In-Stent Restenosis in DES era

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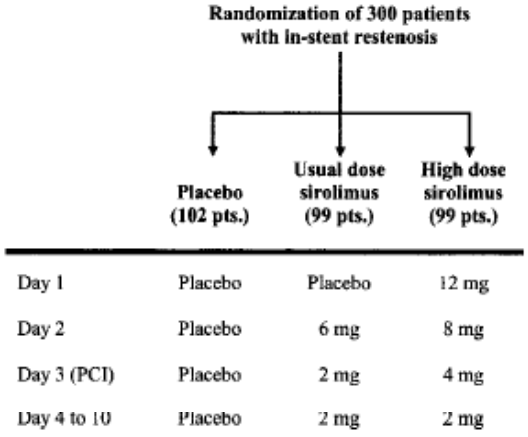
Korea University Medical Center

Restenosis

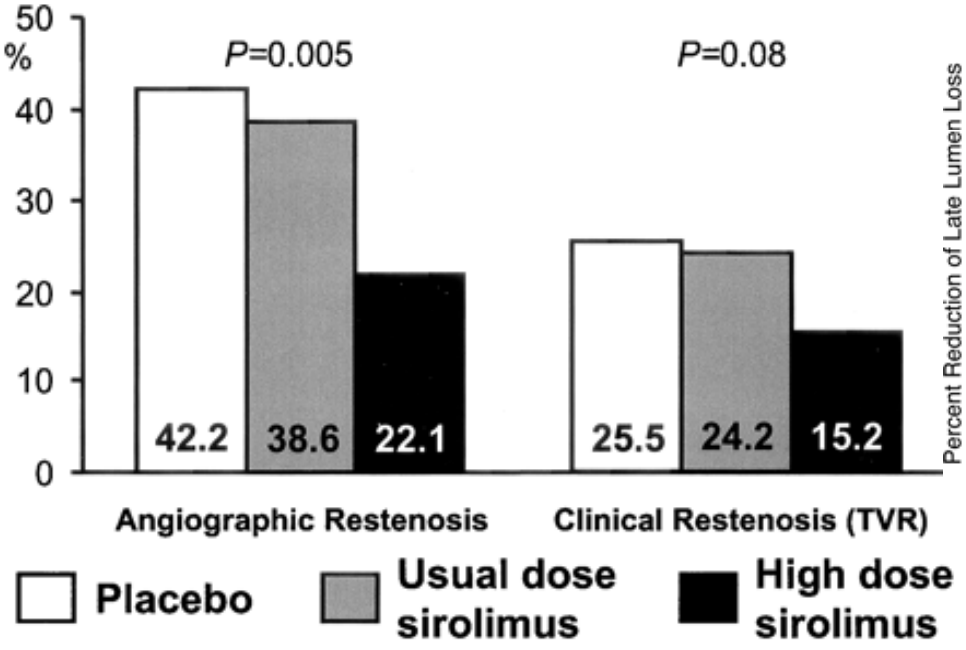
POBA	*BMS*	*DES*
30~50%	**15~30%**	**?**

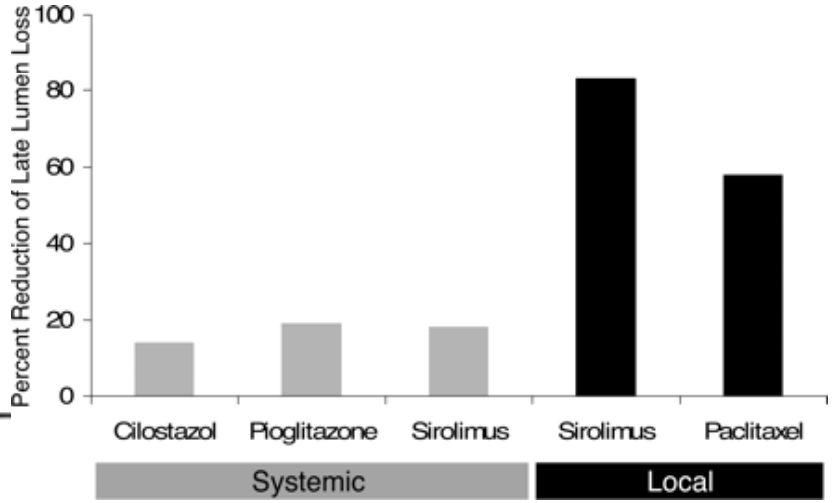
Sirolimus, Systemic vs Local

in OSIRIS Trial



	Placebo (90 Patients)	Usual-Dose Sirolimus (83 Patients)	High-Dose Sirolimus (86 Patients)	*P*
Minimum lumen diameter, mm	1.53±0.61	1.37±0.69	1.66±0.62	0.013
Vessel size, mm	2.70±0.52	2.54±0.63	2.65±0.54	0.173
Diameter stenosis, %	43.7±18.4	45.8±21.5	38.1±17.7	0.028
Late lumen loss, mm	0.60±0.56	0.72±0.70	0.49±0.54	0.048
Net lumen gain, mm	0.68±0.61	0.50±0.69	0.74±0.51	0.028
No. of patients with restenosis	38	32	19	
Incidence of restenosis (CI), %	42.2 (28.1–49.0)	38.6 (13.3–30.9)	22.1 (32.0–52.4)	0.005





Hausleiter J.Circulation 2004

A RANDOMIZED COMPARISON OF A SIROLIMUS-ELUTING STENT WITH A STANDARD STENT FOR CORONARY REVASCULARIZATION

MARIE-CLAUDE MORICE, M.D., PATRICK W. SERRUYS, M.D., PH.D., J. EDUARDO SOUSA, M.D., JEAN FAJADET, M.D., ERNESTO BAN HAYASHI, M.D., MARCO PERIN, M.D., ANTONIO COLOMBO, M.D., G. SCHULER, M.D., PAUL BARRAGAN, M.D., GIULIO GUAGLIUMI, M.D., FERENC MOLNÀR, M.D., AND ROBERT FALOTICO, PH.D., FOR THE RAVEL STUDY GROUP*

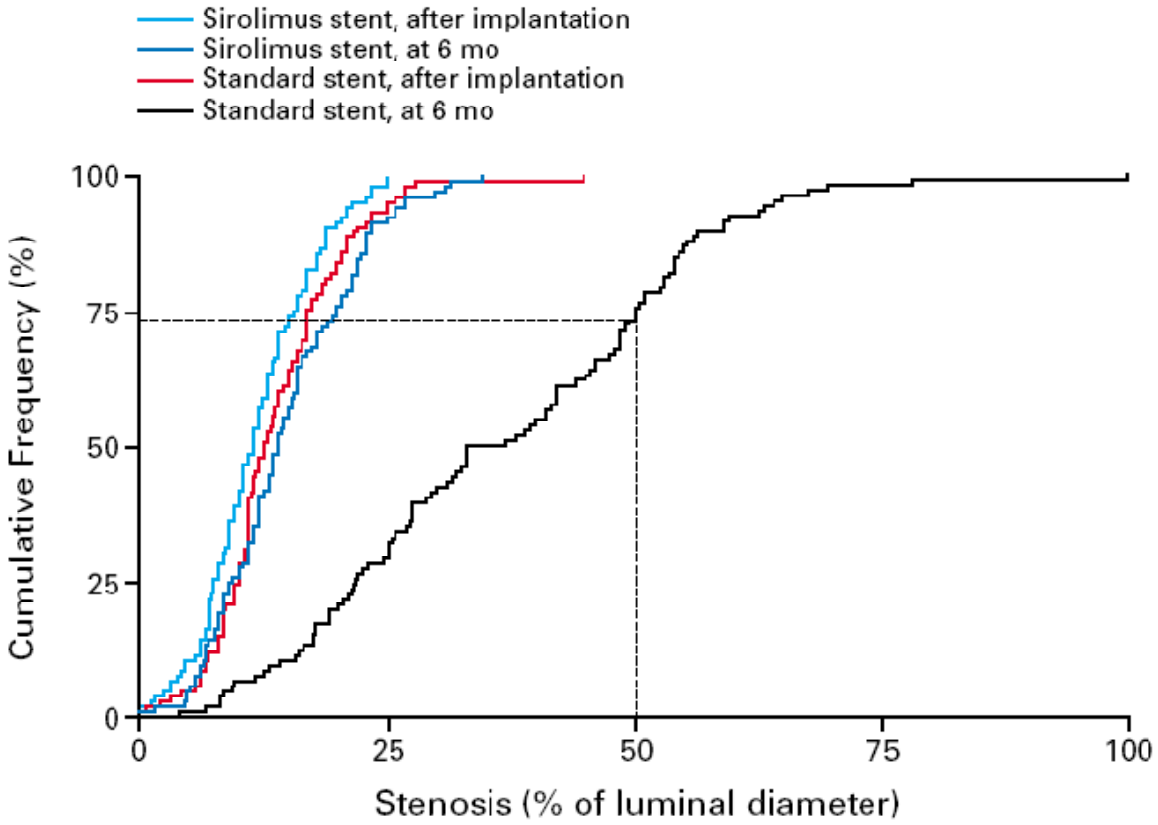


Figure 1. Cumulative Frequency of Stenosis Immediately after Stenting and at Six Months in Patients Who Received Sirolimus-Eluting Stents and in Those Who Received Standard Stents.

The broken lines indicate the percentage of lesions with restenosis (above the line, 22.9 percent) and without restenosis (below the line, 77.1 percent) according to the study definition.

NEJM 2002

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association®
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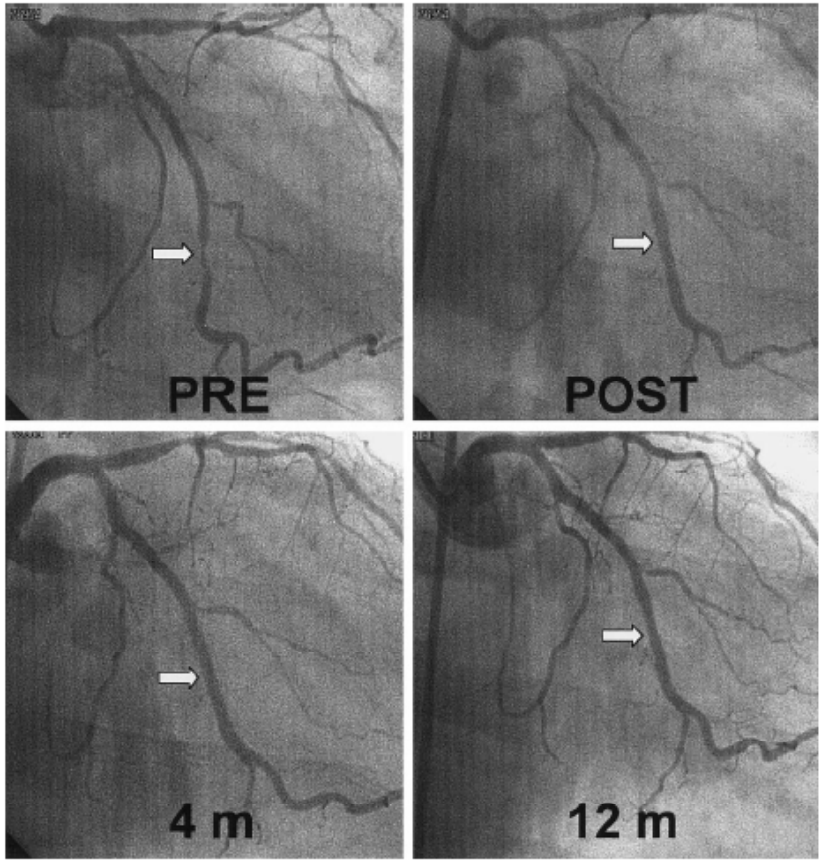
YEAR

2001

Clinical Investigation and Reports

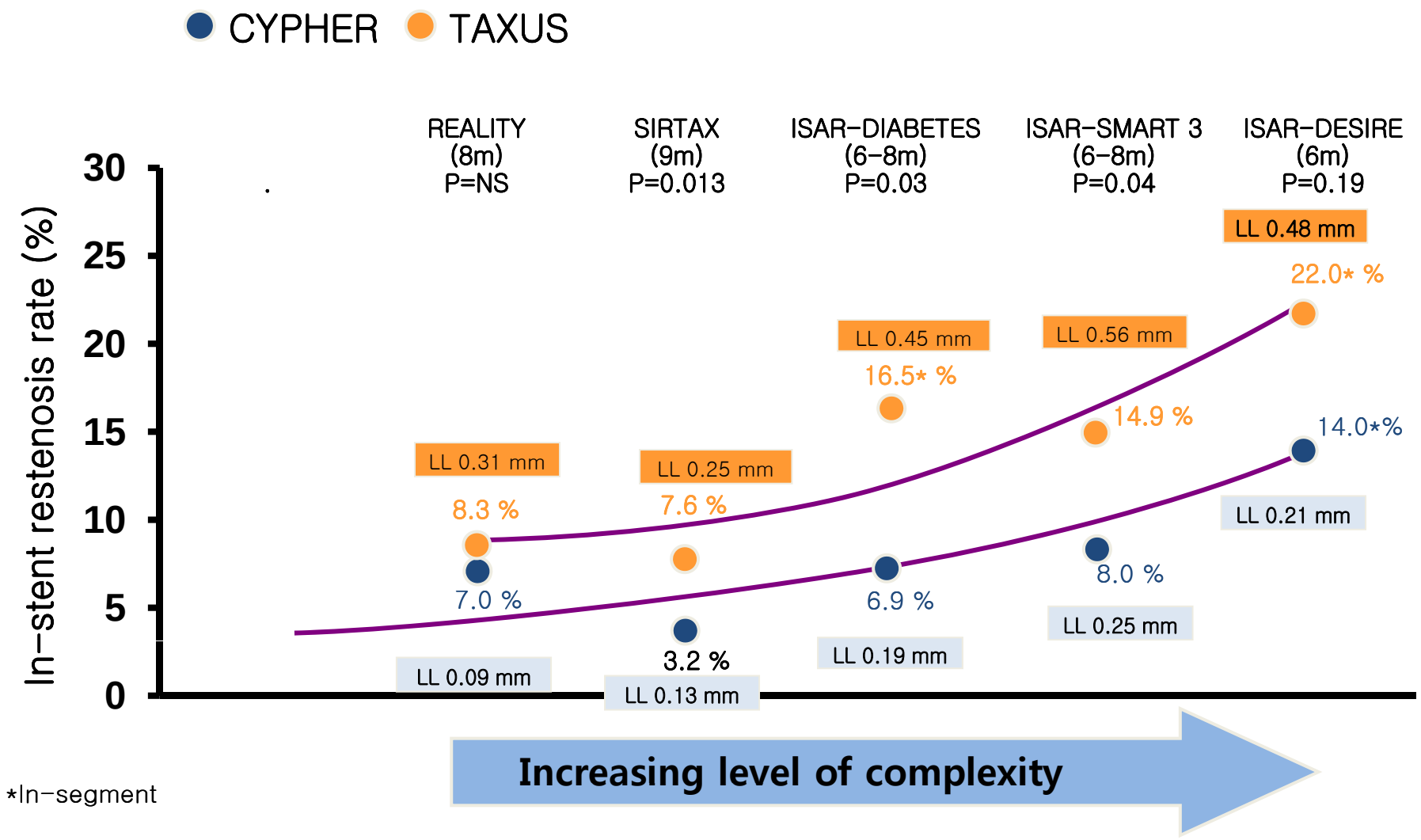
Sustained Suppression of Neointimal Proliferation by Sirolimus-Eluting Stents

One-Year Angiographic and Intravascular Ultrasound Follow-Up



Patrick Serruys – "If I am in a dream, please don't wake me"

In Stent Restenosis

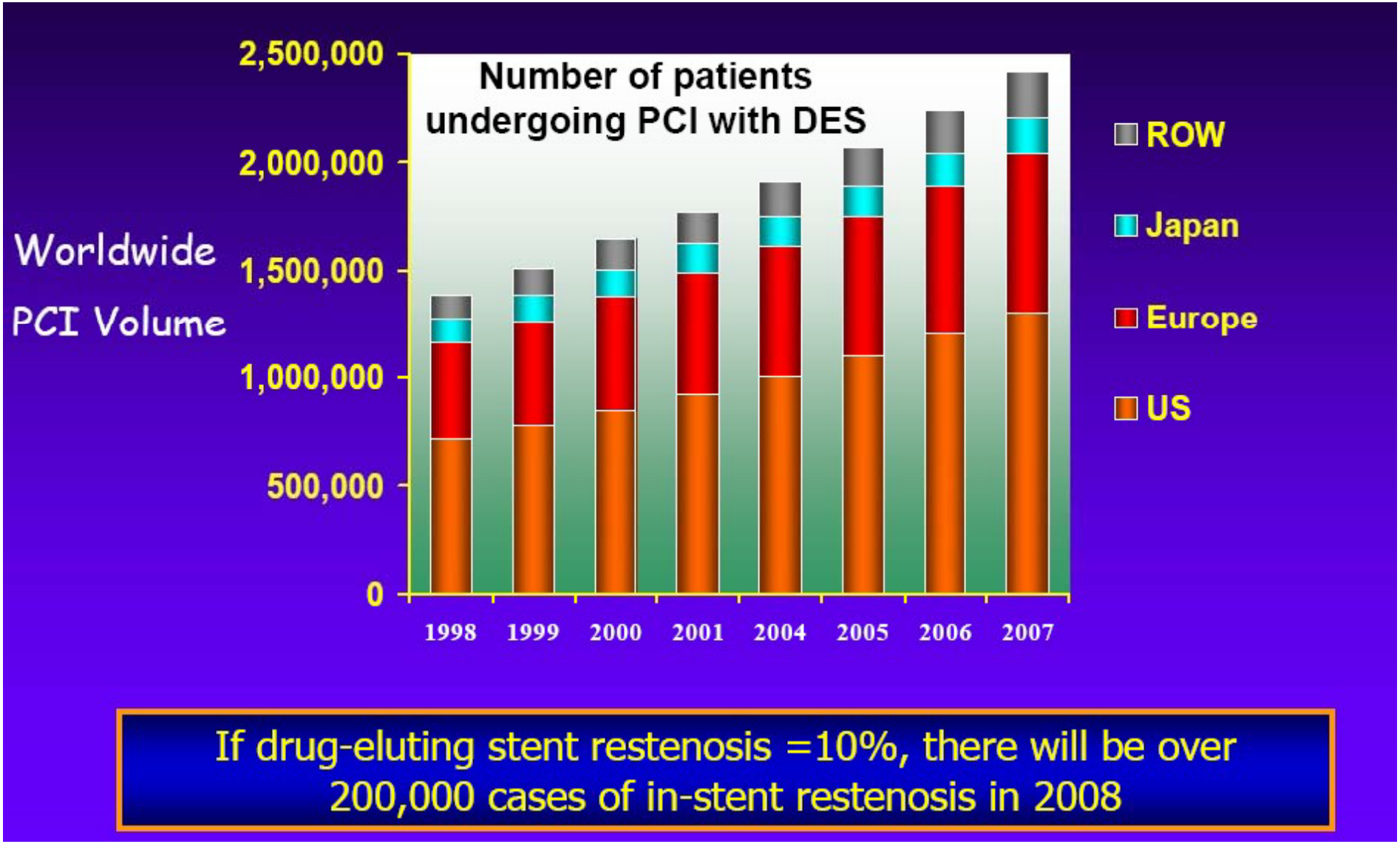


*In-segment

1. Morice MC: ACC, 2005 2. Windecker et al: NEJM 355:653, 2005 3. Dibra et al: NEJM 355:663, 2005
4. Kastrati A: ESC, 2004 5. Kandzari D: TCT, 2005 6. Mehili et al: Eur Heart J 27: 260, 2006

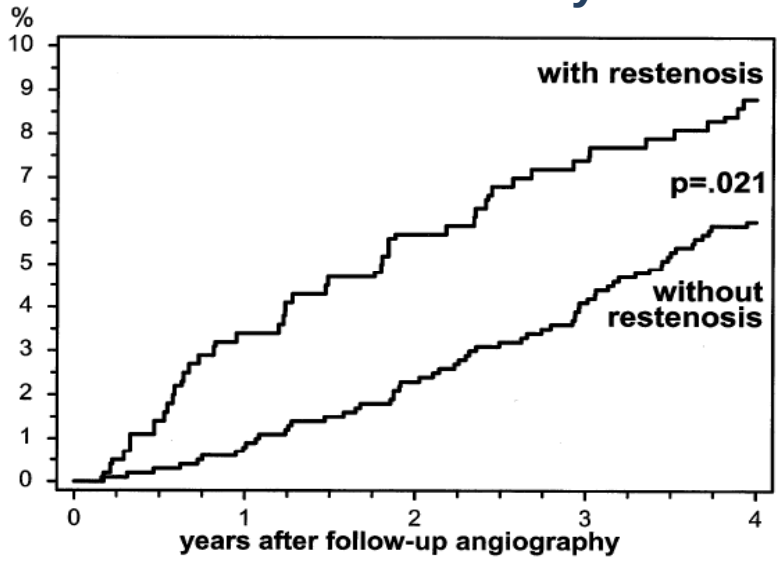
ISR of DES

The Scope of The Problem



In-stent Restenosis is not benign !!

Cumulative mortality curve



Cumulative mortality curves for all patients with FU angio, differentiating patients with and without angiographic restenosis.

Am Heart J 2004;147:317~322

Cleveland Clinic 1186 cases of BMS ISR

64.1% Effort angina

26.4% Unstable angina

9.5% Acute MI

0.7% Procedural death

Chen MS et al. AHJ 2006

Story of Restenosis

- Pathophysiology & mechanism of ISR
- Predictors of ISR : BMS vs. DES
- Treatment strategy for ISR in DES era
- Future perspective and randomized controlled trial

Story of Restenosis

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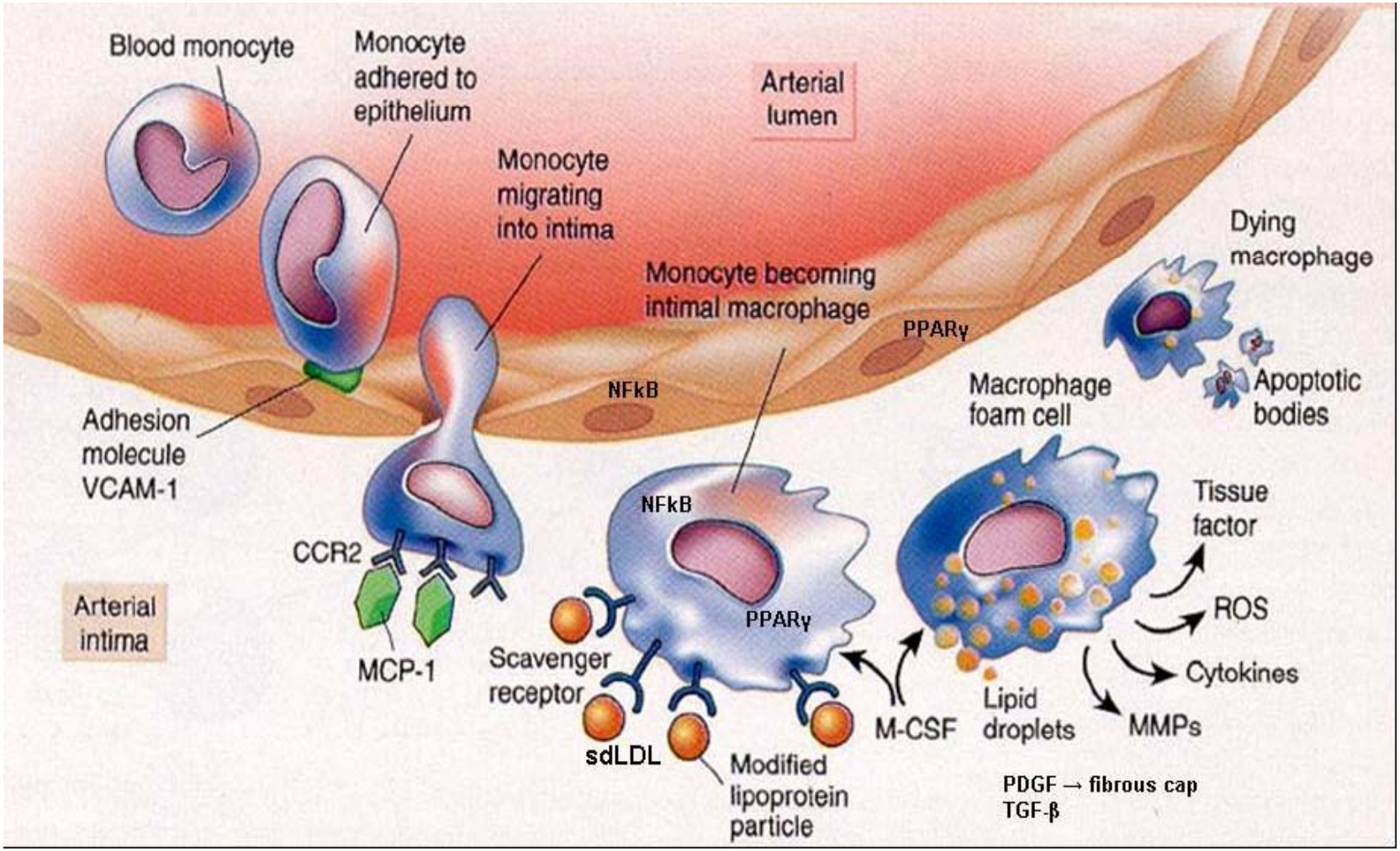
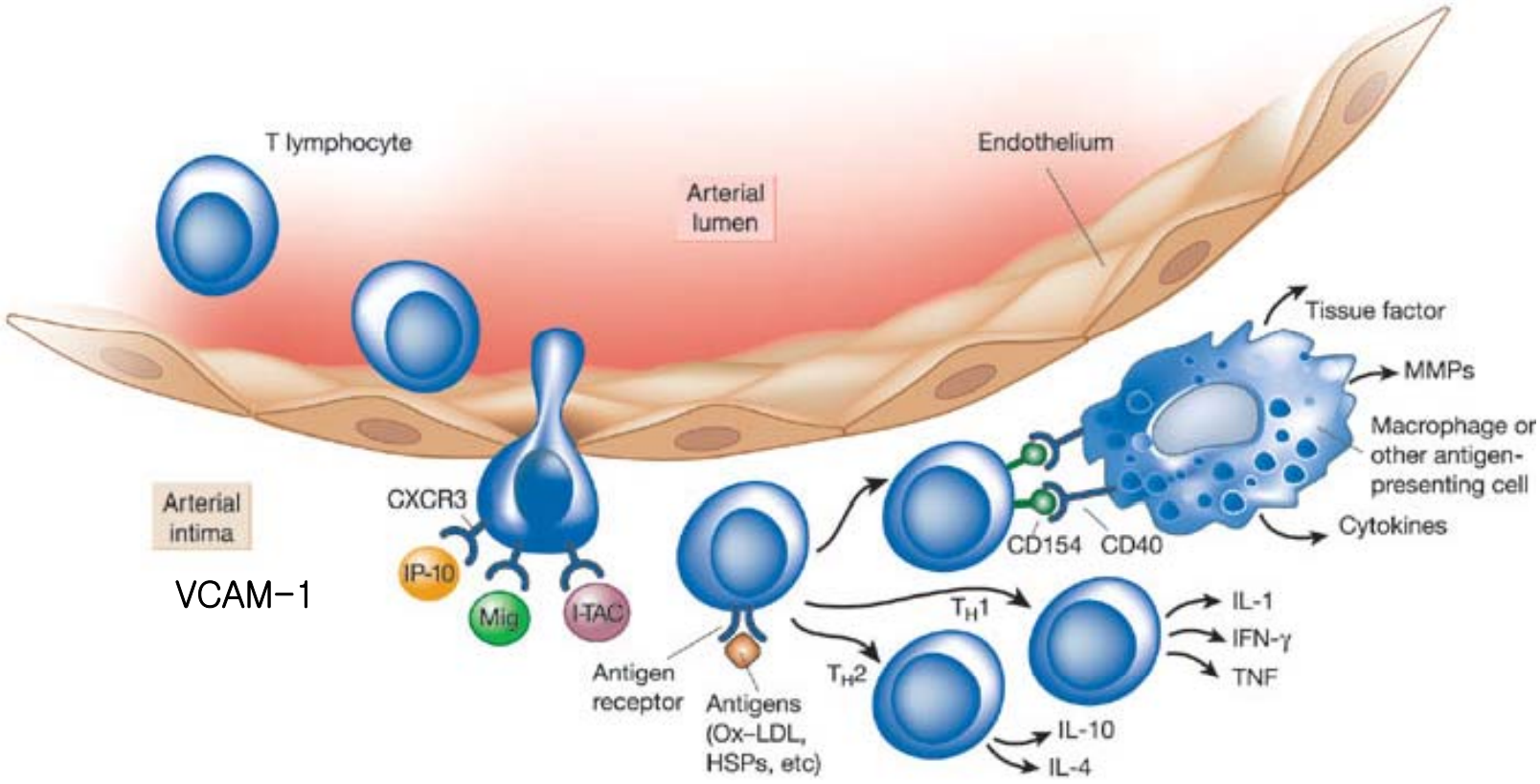
Atherosclerosis lesions and inflammation



Various chemokines seem to participate in this process, particularly interaction of MCP-1 with its receptor CCR2

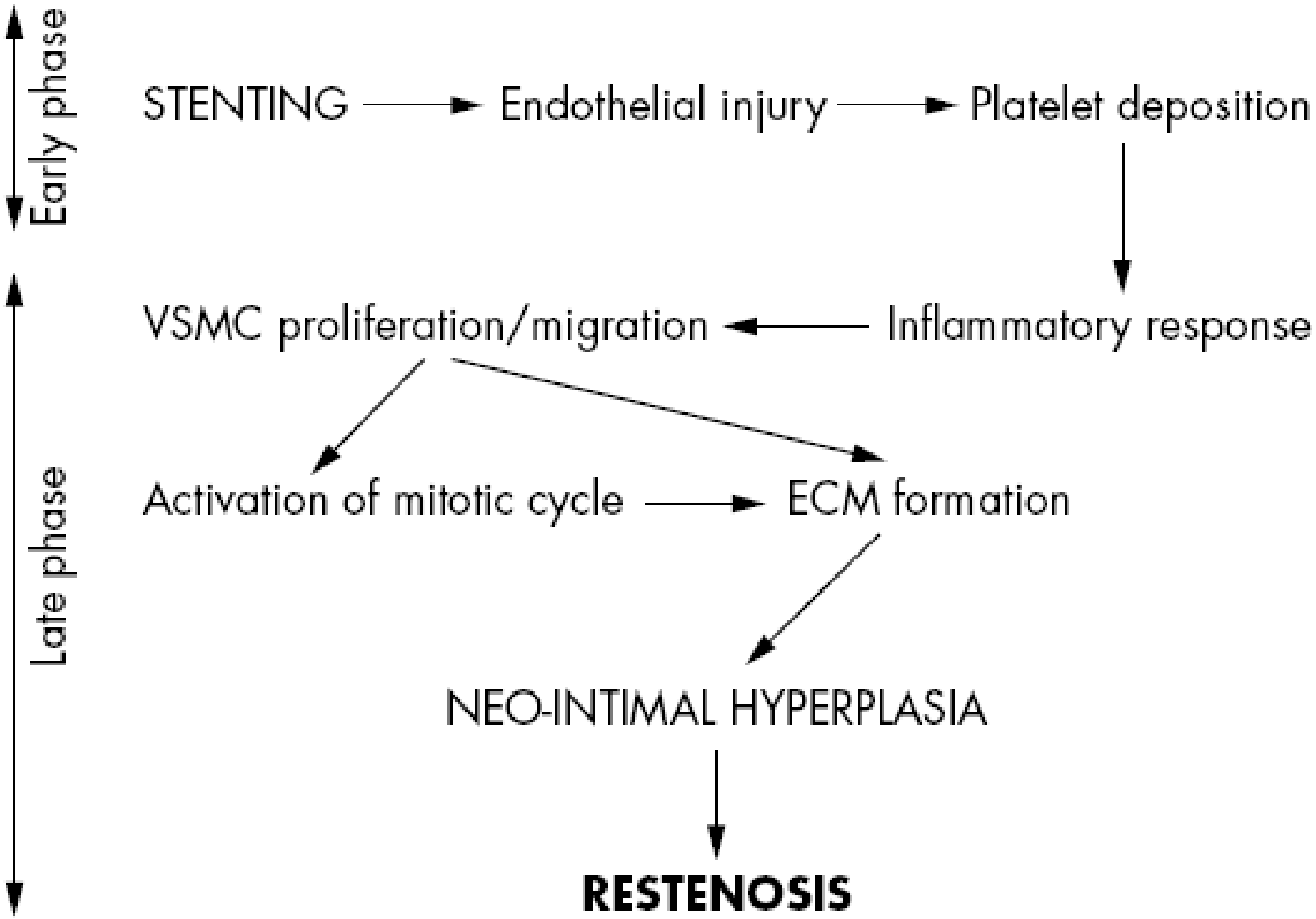
Libby P. Nature 2002; 420(19/26):869-74.

The roles of T lymphocytes in atherogenesis.



Chemoattractants bind to chemokine receptor CXCR3 expressed by T cells in the atherosclerotic lesion

Pathophysiology of Restenosis



Pathophysiology in Early phase of Restenosis

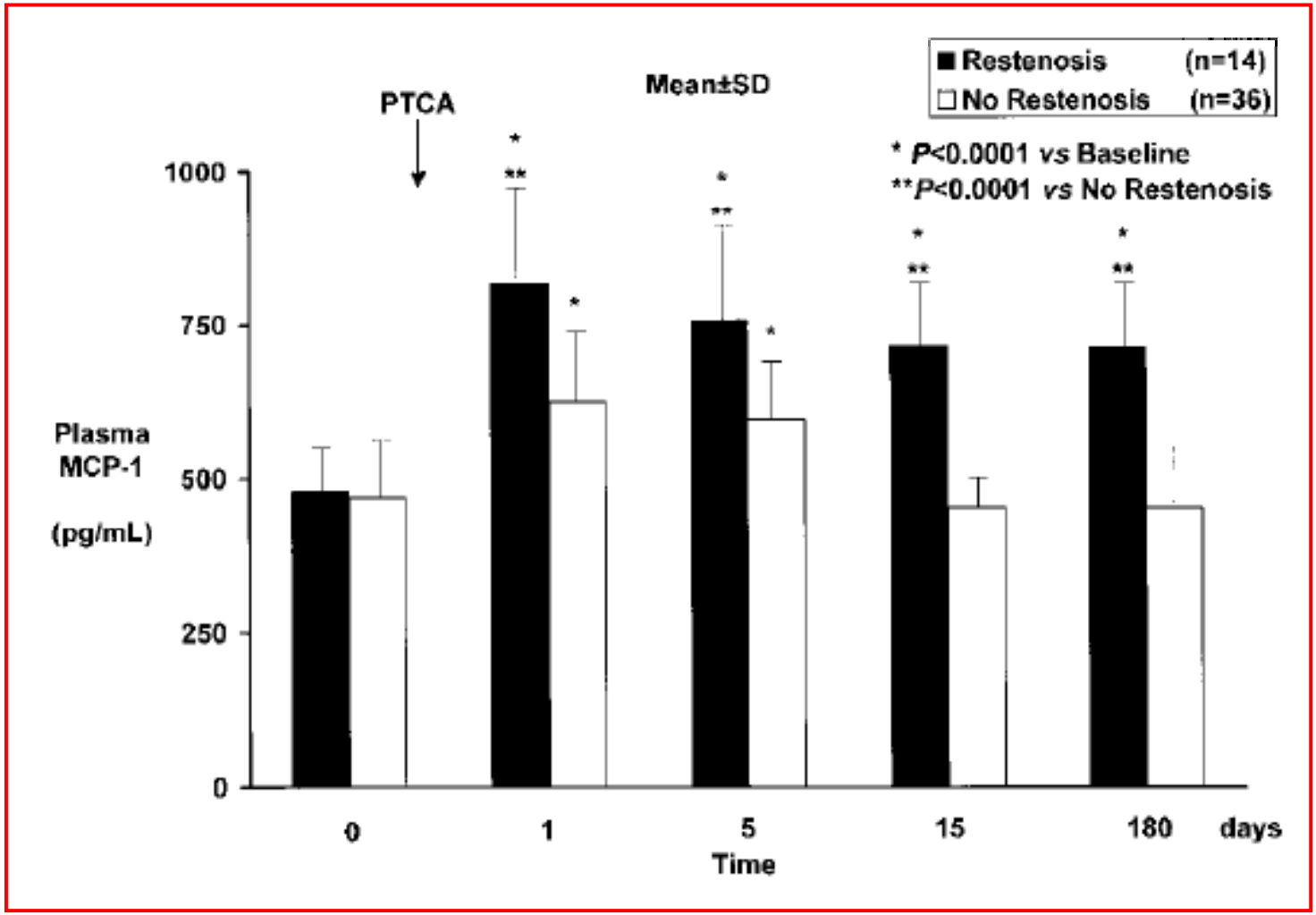
- **From the Stent injury**
  - Adhesion molecules by endothelial cells
  - Binding on leukocytes
  - Interaction of leukocytes with endothelium
  - Attachment of platelet mediated by selectins
  - Transmigration of leukocytes across platelet – coated surface
  - Thrombus formation
  - Fibrin & platelet deposition at injury site

    Inflammatory aggregate
  - Further leucocyte recruitment & infiltration

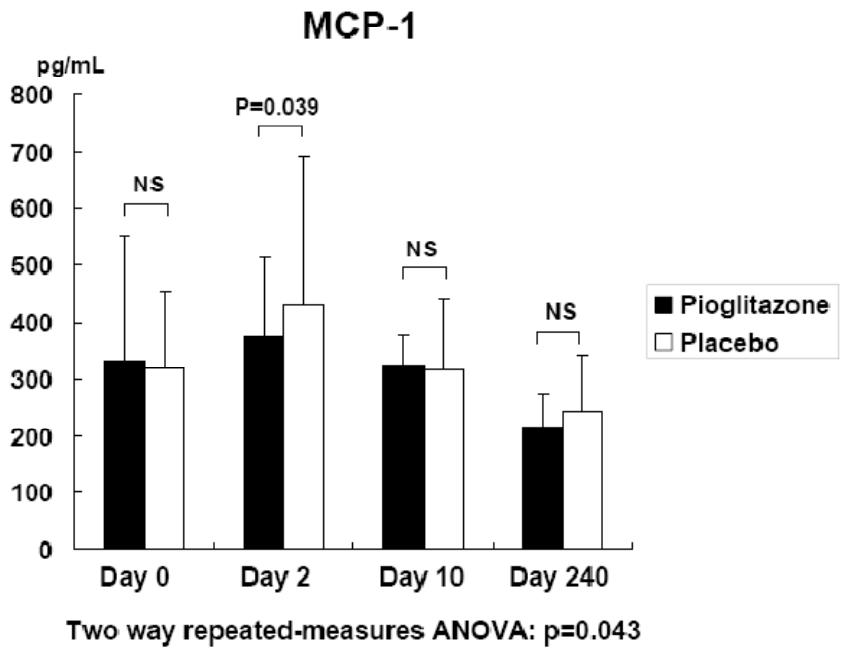
Role of adhesion molecules and chemoattractants in early phase of restenosis

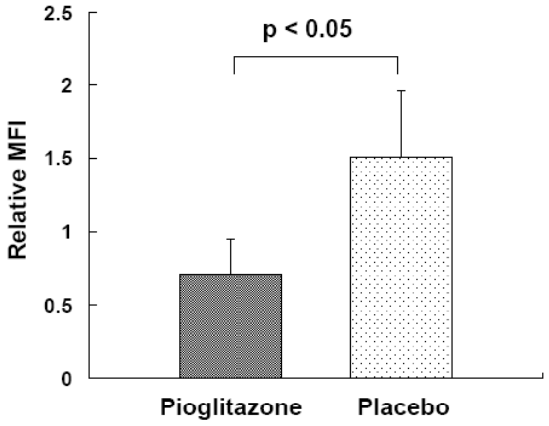
- Mac-1 (CD11b/CD18)
  - On neutrophils & monocyte
  - Leukocyte recruitment after vascular injury
  - Adhesion of neutrophil, monocytes to endothelial cells
  - Binding of platelet to neutrophil
  - Amplify the inflammatory response
- MCP-1
  - Secreted by activated platelet.
  - Direct migration of monocytes into intima at lesion sites
- CD 40L (TNF family)
  - Mediation of platelet and endothelial cell interaction
  - Inhibition of re-endothelialization of endothelial cell layer
- M-CSF
  - Differentiation of monocyte into macrophage
  - Expression of macrophage scavenger receptor leading to foam cell

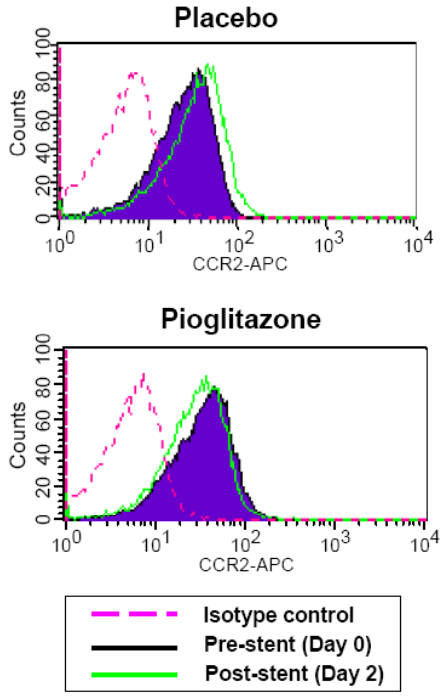
MCP-1 expression in restenosis after PCI



Level of MCP-1 and CCR2 expression





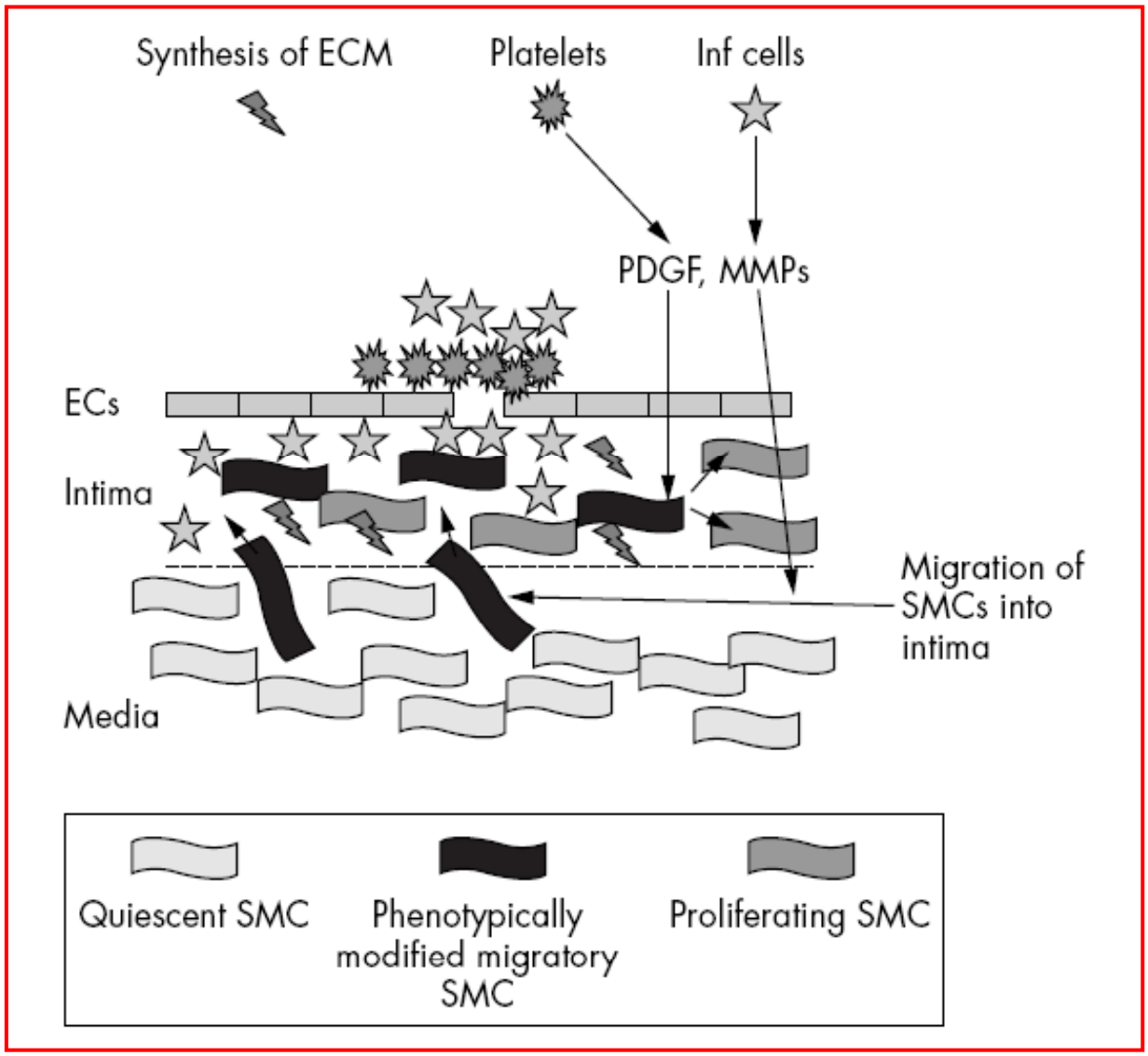


Decreased MCP-1 inhibits the monocyte infiltration from lumen into the stent lesion, that causes reduction of the monocytes differentiation into macrophages

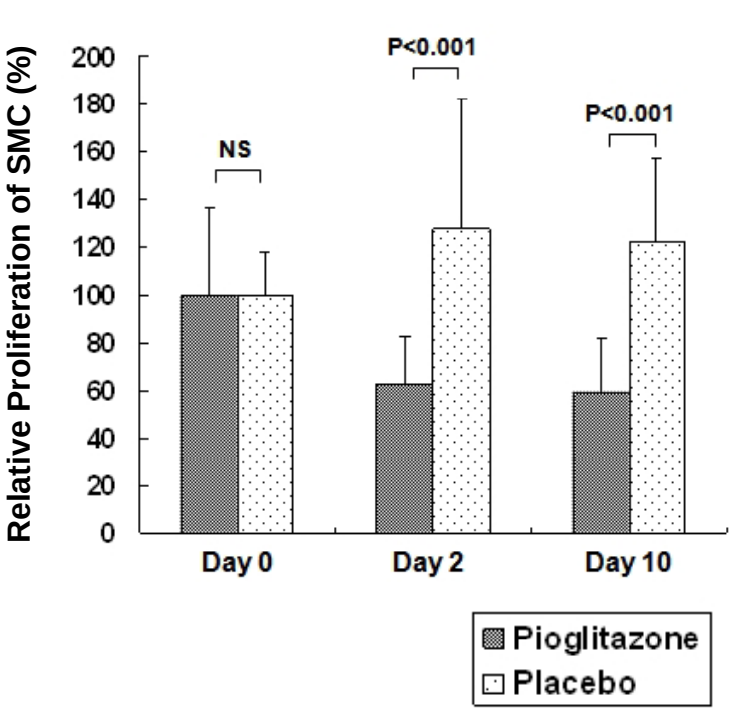
Pathophysiology in Late phase of Restenosis

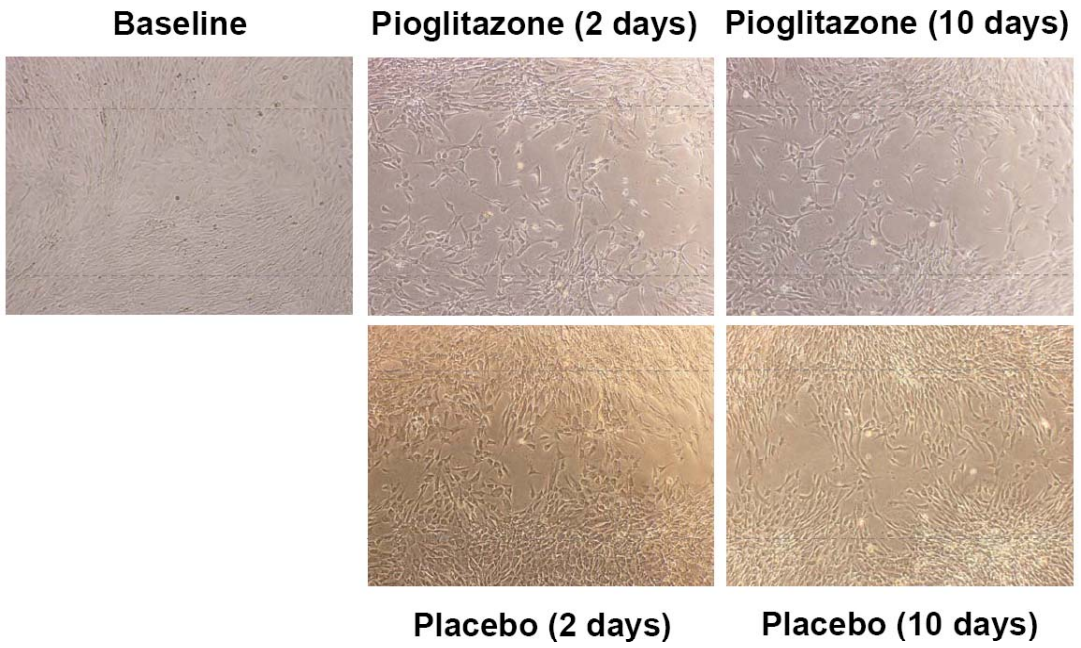
- Phenotypic modification of medial smooth muscle cells
- Migration and subsequent proliferation in the intima.
- Coordinated Extra Cellular Matrix synthesis by smooth muscle cells
- Increasing volume of intimal tissue

Migration and proliferation of smooth muscle cells after stenting



Inhibition of proliferation of smooth muscle cell

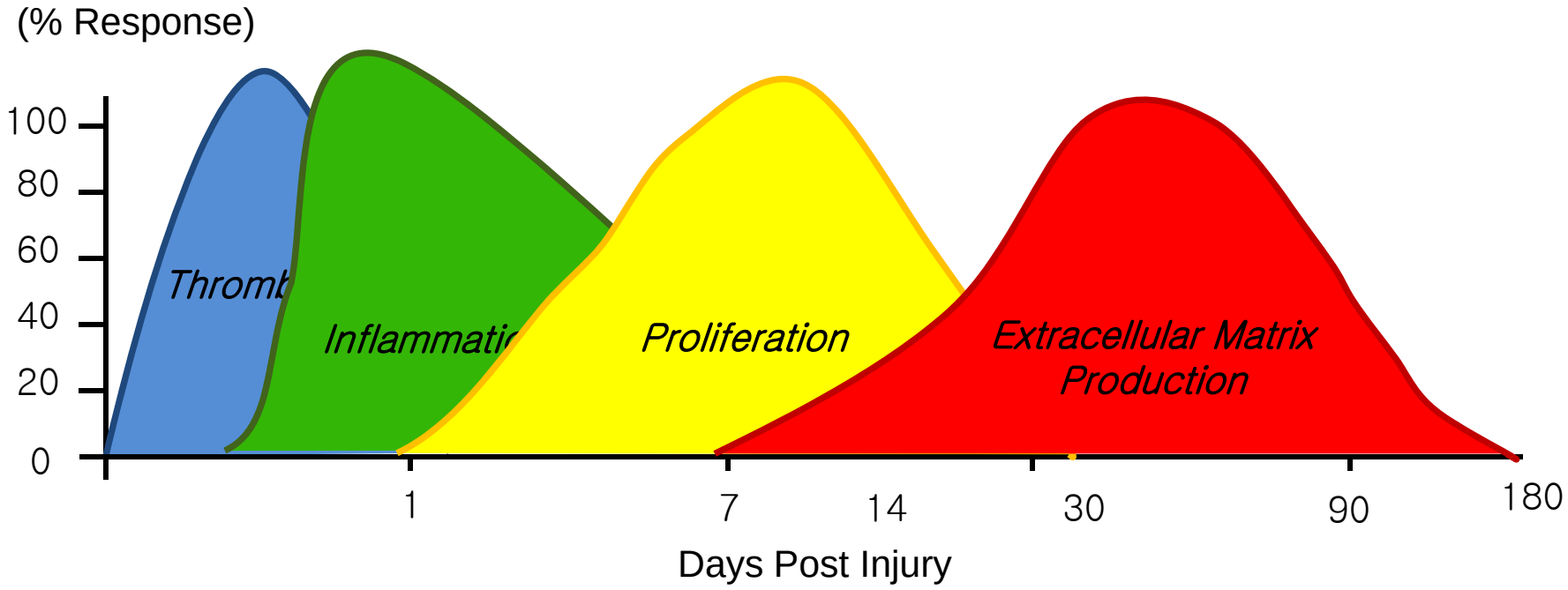




Plasma from Pio Group after 2 days and 10 days inhibited human aortic SMC migration, contributes to reducing neointimal growth after stenting

Pathophysiology of In-Stent Restenosis

- **Neointimal hyperplasia**
  - **Early thrombus formation**
  - **Acute inflammatory response**
  - **Smooth muscle cell migration and proliferation**
  - **Extracelluar matrix formation**

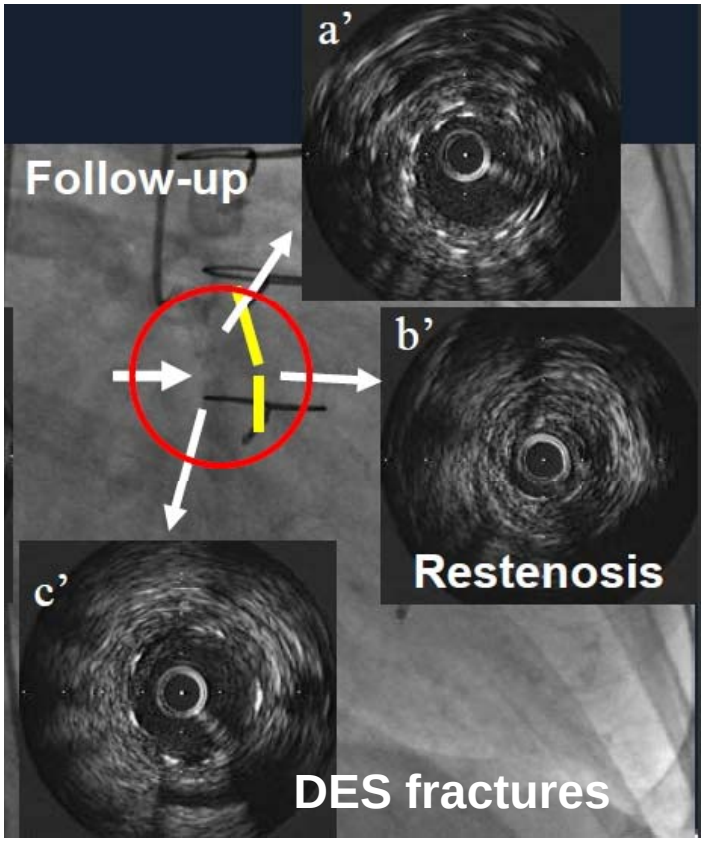


Mechanism of DES Restenosis

"More complex than BMS"

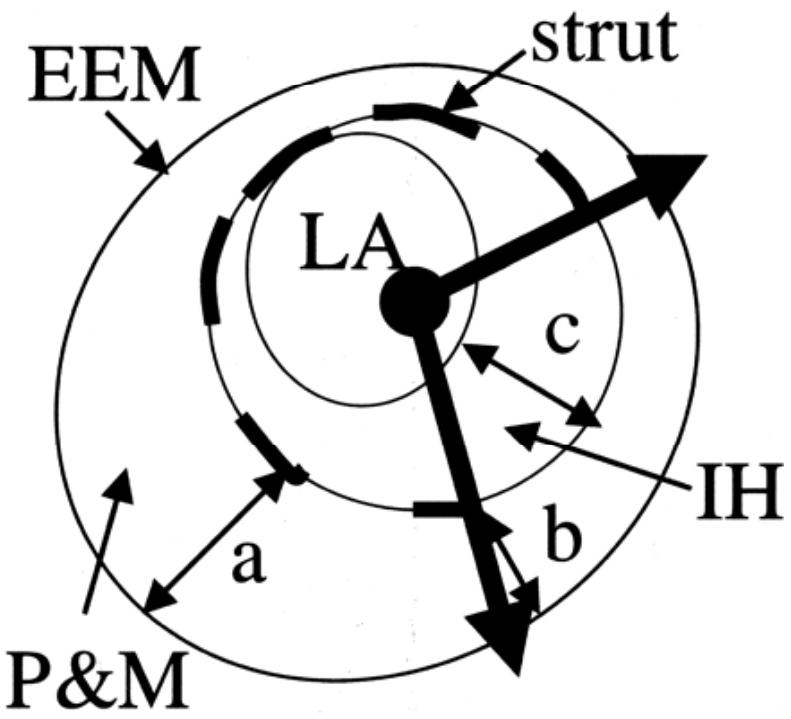
- **Biological factor**
  - ✓ Drug resistence
  - ✓ Hypersensitivity

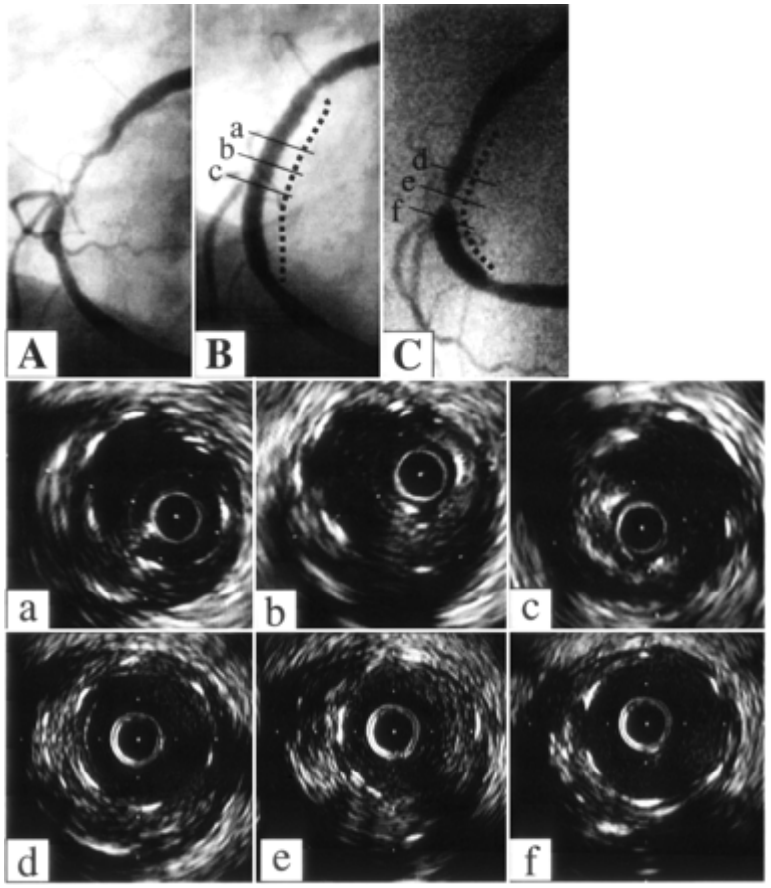
- **Mechanical factor**
  - ✓ Non uniform stent strut distribution
  - ✓ Stent fractures
  - ✓ Polymer peeling
  - ✓ Non uniform drug deposition



- **Technical factors**
  - ✓ Incomplete stent expansion
  - ✓ Stent Gaps or misses (uncovered lesion segments)
  - ✓ Barotrauma to unstented segments

Nonuniform Strut Distribution Correlates With More Neointimal Hyperplasia after SES

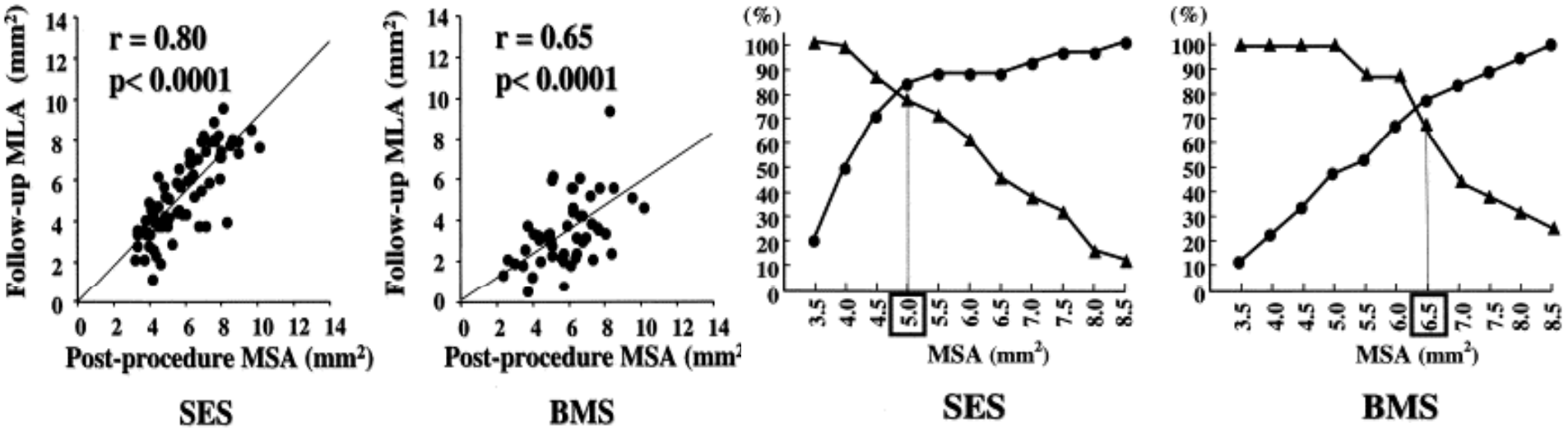




Takebayashi, Circulation 2004

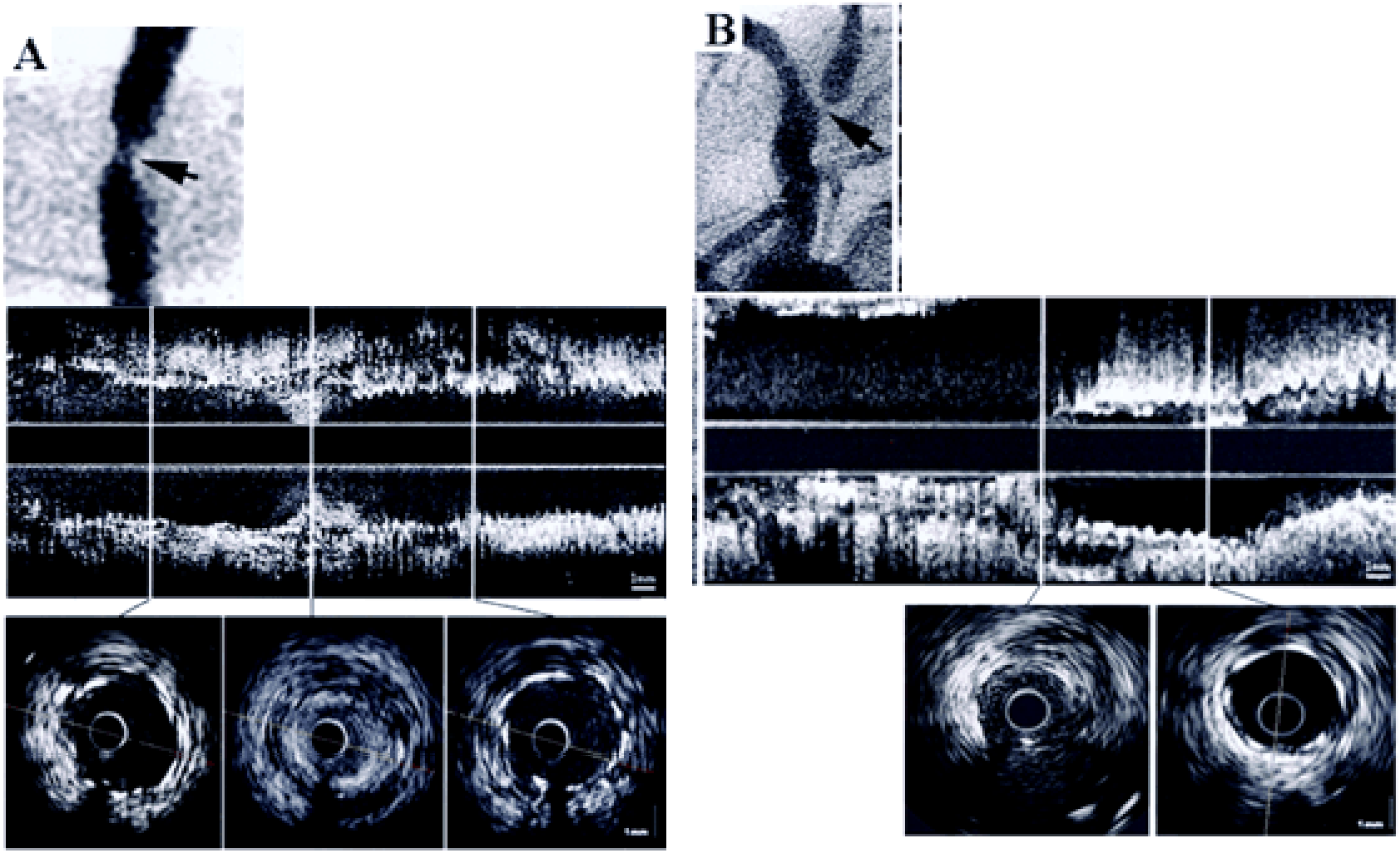
Impact of Final Stent Dimensions on Long-Term Results Following Sirolimus-Eluting Stent Implantation

Serial Intravascular Ultrasound Analysis From the SIRIUS Trial

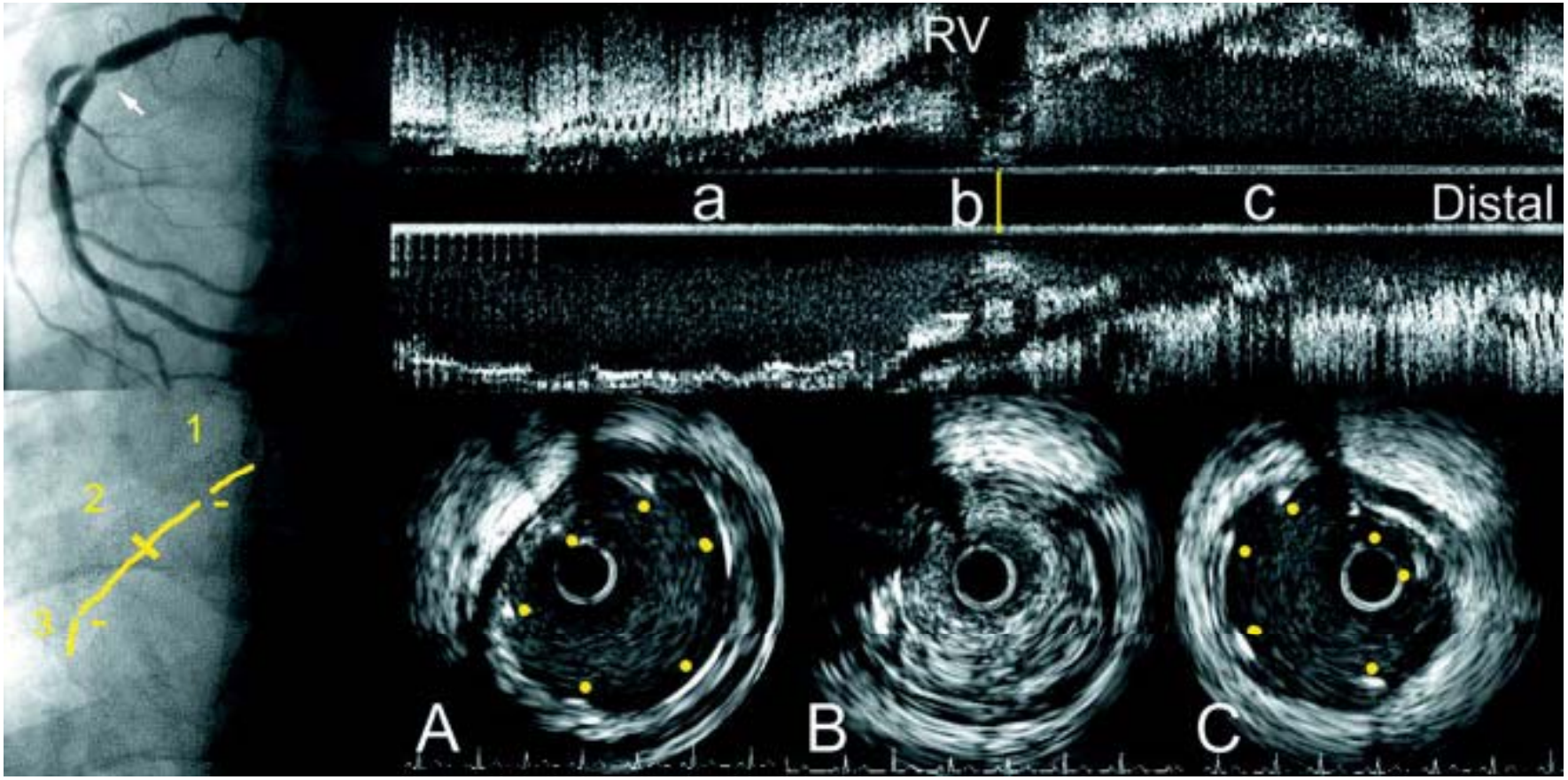


Sonoda S, JACC 2004

Focal restenosis at a gap between stents



Restenosis due to Stent Fracture



Story of Restenosis

- Pathophysiology & mechanism of ISR
- Predictors of ISR : BMS vs. DES
- Treatment strategy for ISR in DES era
- Future perspective and randomized controlled trial

Clinical, Angiographic, and Procedural Predictors of Angiographic Restenosis After Sirolimus-Eluting Stent Implantation in Complex Patients

An Evaluation From the Rapamycin-Eluting Stent Evaluated At Rotterdam Cardiology Hospital (RESEARCH) Study

T/ linical, Procedural, and Angiographic Univariate Predictors of In-Segment Restenosis After SES Restenosis

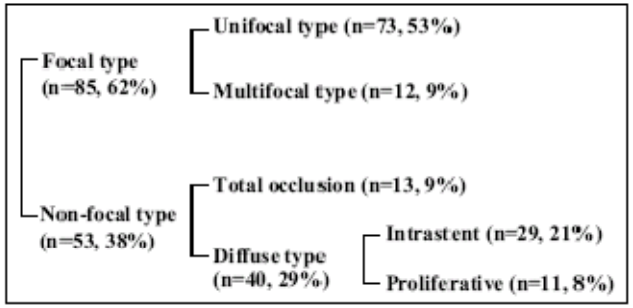
	OR	95% CI	*P*
Bypass graft	4.61	1.39–15.33	0.01
Treatment of in-stent restenosis	3.66	1.68–7.96	<0.01
Previous bypass surgery	3.24	1.42–7.41	<0.01
Bifurcation stenting (side branch position)	2.77	1.15–6.33	0.02
Ostial location	2.66	1.30–5.46	<0.01
Diabetes mellitus	2.54	1.24–5.21	0.01
No. of stents implanted	1.62	1.19–2.22	<0.01
Postprocedure diameter stenosis (per 10% increase)	1.55	1.14–2.10	<0.01
Total stented length (per 10-mm increase)	1.30	1.14–1.48	<0.01
Preprocedure minimal luminal diameter	0.46	0.22–0.95	0.04
Postprocedure minimal luminal diameter	0.39	0.20–0.76	<0.01
Left anterior descending artery	0.37	0.16–0.82	0.02
Acute myocardial infarction	0	...	<0.01

Clinical, Procedural, and Angiographic Multivariate Predictors of In-Segment Restenosis After SES Restenosis*

	OR	95% CI	*P*
Treatment of in-stent restenosis	4.16	1.63–11.01	<0.01
Ostial location	4.84	1.81–12.07	<0.01
Diabetes mellitus	2.63	1.14–6.31	0.02
Total stented length (per 10-mm increase)	1.42	1.21–1.68	<0.01
Reference diameter (per 1.0-mm increase)	0.46	0.24–0.87	0.03
Left anterior descending artery	0.30	0.10–0.69	<0.01

Lemos PA, Circulation 2004

Predictors of Restenosis After Placement of Drug-Eluting Stents in One or More Coronary Arteries



Variable	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	p Value	OR	95% CI	p Value
Use of Taxus stent	4.064	2.837–5.814	<0.001	4.367	2.899–6.579	<0.001
Postintervention minimal lumen diameter	0.294	0.197–0.441	<0.001	0.319	0.202–0.503	<0.001
Lesion length	1.026	1.015–1.038	<0.001	1.023	1.010–1.035	<0.001
Total stent length	1.025	1.014–1.032	<0.001			
Stent length >40 mm	2.431	1.698–3.482	<0.001			
Stent per lesion	1.190	1.039–1.364	0.012			
Reference artery diameter	0.442	0.297–0.658	<0.001			
Reference artery diameter <2.5 mm	1.884	1.258–2.821	0.002			
Preintervention minimal lumen diameter	0.594	0.427–0.825	0.002			
Preintervention diameter stenosis	1.011	1.001–1.021	0.038			
Acute gain	0.702	0.513–0.961	0.027			
Type B2/C lesions	2.774	1.624–4.739	<0.001			

Lee CW, Am J Cardiol. 2006

Multiple predictors of coronary restenosis after drug-eluting stent implantation in patients with diabetes

S J Hong, M H Kim, T H Ahn, Y K Ahn, J H Bae, W J Shim, Y M Ro, D-S Lim

Table 4 Logistic regression analysis for predicting restenosis in patients with diabetes

	Univariate			Multivariate		
Parameter	p Value	OR	95% CI	p Value	O	
Age	0.199	1.024	0.988 to 1.062			
Women	0.352	0.705	0.338 to 1.471			
Body mass index	0.565	1.038	0.914 to 1.178			
Unstable angina	0.219	1.525	0.778 to 2.990			
Stable angina	0.016	0.408	0.197 to 0.846	0.229	0.	
Left ventricular ejection fraction	0.997	1.000	0.967 to 1.033			
Risk factor						
Hypertension	0.042	2.383	1.031 to 5.506	0.184	1.	
Smoking	0.030	2.127	1.075 to 4.210	0.036	1.	
Hypercholesterolaemia	0.328	1.564	0.638 to 3.834			
Lesion location						
Left anterior descending	0.138	0.587	0.290 to 1.186			
Left circumflex	0.966	1.017	0.460 to 2.252			
Right coronary	0.984	0.992	0.461 to 2.136			
Left main	0.129	2.474	0.985 to 6.213			
Quantitative coronary angiography						
Pre-PCI reference diameter	0.004	0.306	0.138 to 0.680	0.040	0.501	0.110 to 0.965
Pre-PCI MLD	0.702	0.811	0.279 to 2.363			
Post-PCI reference diameter	0.003	0.283	0.123 to 0.653	0.026	0.455	0.120 to 0.814
Post-PCI MLD	0.001	0.131	0.047 to 0.369	0.039	0.447	0.068 to 0.876
Stent length (mm)	0.003	1.104	1.035 to 1.178	0.033	1.065	1.021 to 1.119
PES implantation	<0.001	5.160	2.521 to 10.565	0.005	2.638	1.338 to 5.200
Laboratory analysis						
hsCRP	0.016	1.218	1.037 to 1.430	0.043	1.031	1.011 to 1.075
ESR	0.052	1.033	1.000 to 1.068			
Total cholesterol	0.015	1.014	1.003 to 1.026	0.489	1.008	0.892 to 1.326
HDL cholesterol	0.020	1.041	1.006 to 1.078	0.527	0.997	0.903 to 1.578
Triglycerides	0.834	0.999	0.994 to 1.005			
LDL cholesterol	0.204	1.009	0.995 to 1.023			
Creatinine	0.558	0.800	0.380 to 1.685			

ESR, erythrocyte sedimentation rate; HDL, high-density lipoprotein; hsCRP, high-sensitive C reactive protein; LDL, low-density lipoprotein; MLD, minimum lumen diameter; OR, odds ratio; PCI, percutaneous coronary intervention; PES, paclitaxel-eluting stent.

- small baseline vessel size
- small vessel size after PCI
- longer stent length
- use of the PES
- current smoking
- high CRP

Heart. 2006;92

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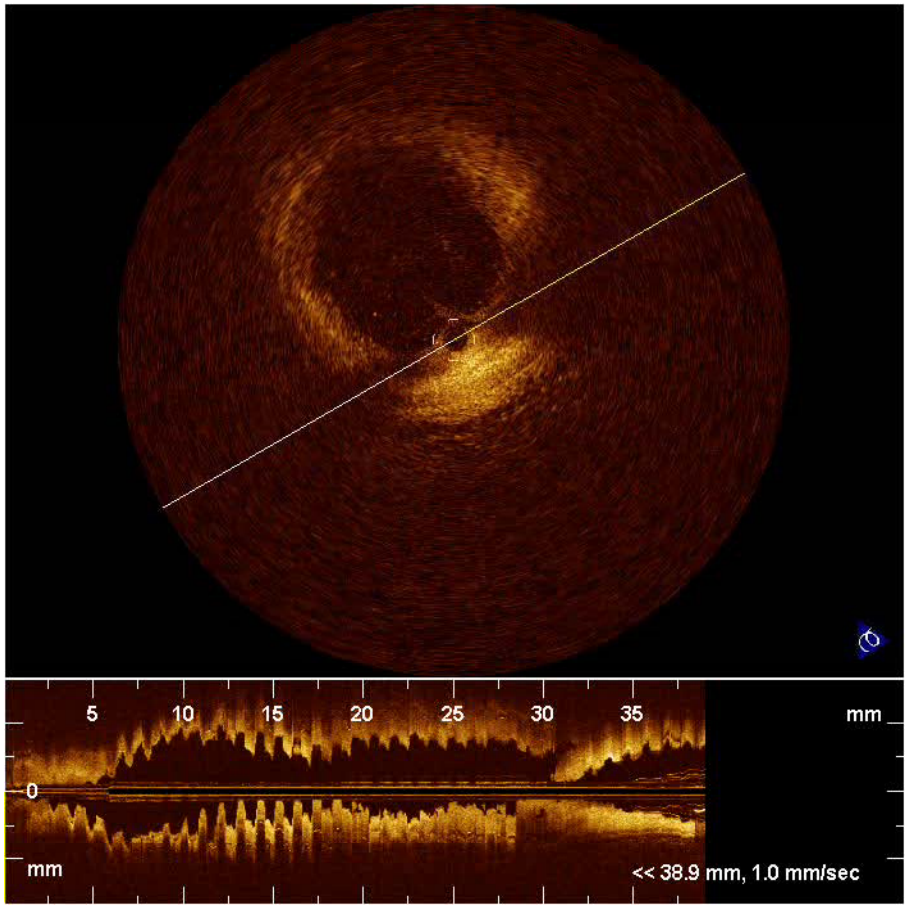
Therapeutic Options for ISR Lesions

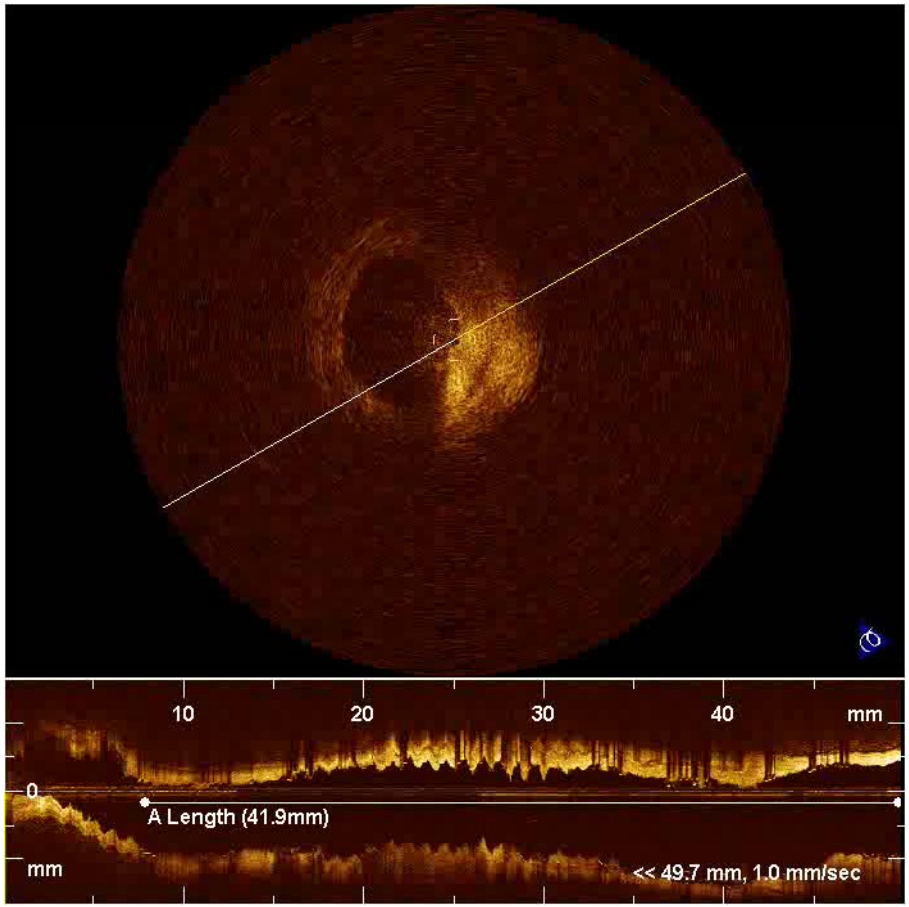
- Medical Therapy
- POBA
- Cutting balloon angioplasty (CBA)
- Vascular Brachytherapy (VBT)
- 1st generation DES : Cypher®, Taxus®
- 2nd generation DES : Endevour®, Xience®

OCT findings after Cutting balloon and DES

Cutting Balloon



Cypher 3.0 x 33



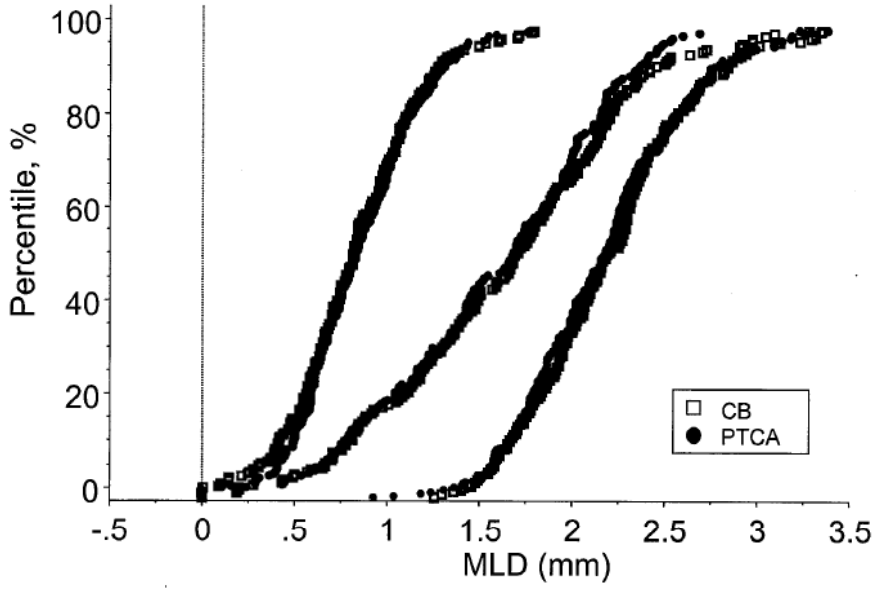
The RESCUT Trial

Cutting balloon vs. POBA

	CBA (n = 214)	PTCA (n = 214)	p Value
During hospital stay			
Death	0	0	
MI	1 (0.5%)	2 (0.9%)	0.99
CABG	0	0	
Bleeding or vascular complications	4 (1.8%)	1 (0.5%)	0.37
After 30 days since hospital discharge			
Death	0	0	
MI	1 (0.5%)	0	0.99
CABG	0	0	
Repeat PCI	1 (0.5%)	1 (0.5%)	1
Bleeding or vascular complications	1 (0.5%)	0	0.99
Subacute occlusion	0	0	
Cumulative (in and out of hospital) MACE at 7 months†			
Death	3 (1.4%)	2 (0.9%)	0.99
MI	3 (1.4%)	3 (1.4%)	1
TLR (repeat PCI and CABG)	29 (13.5%)	28 (13.1%)	0.99
Total patients with MACE	35 (16.4%)	33 (15.4%)	0.79

*Death, MI, CABG, and repeat PCI, TLR. †Patients with more than one MACE were counted only one time for the most severe MACE. ‡p values are calculated according to the Fisher exact test. Data are presented as the number (%) of patients.

CABG = coronary artery bypass graft surgery; MACE = major adverse cardiac events; MI = myocardial infarction; PCI = percutaneous coronary intervention; TLR = target lesion revascularization; other abbreviations as in Table 1.

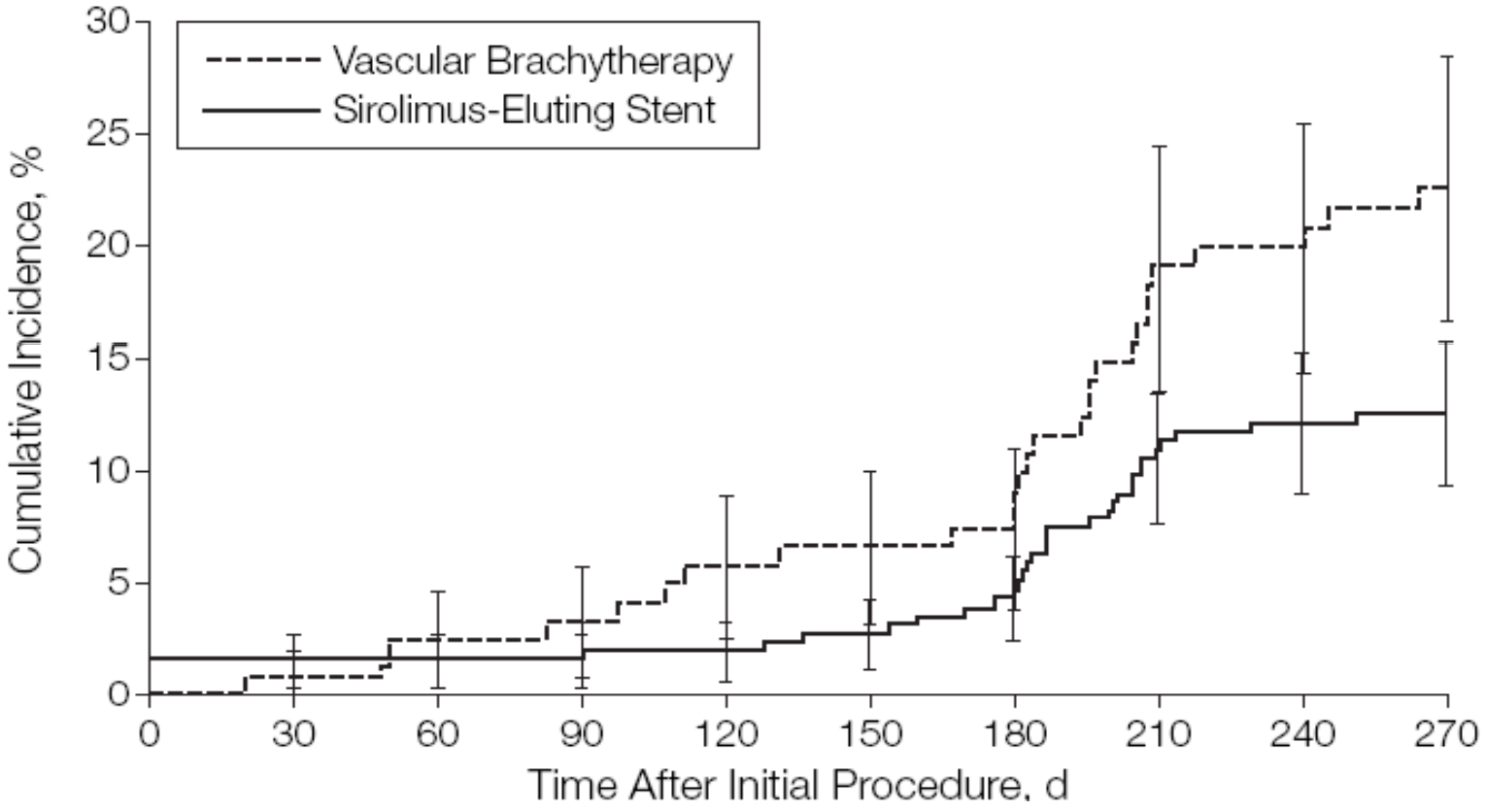


→ **No additional benefit of CBA**

Remo Albiero et al. *JACC* 2004

SISR Trial: Brachytherapy vs. DES

9-month follow-up

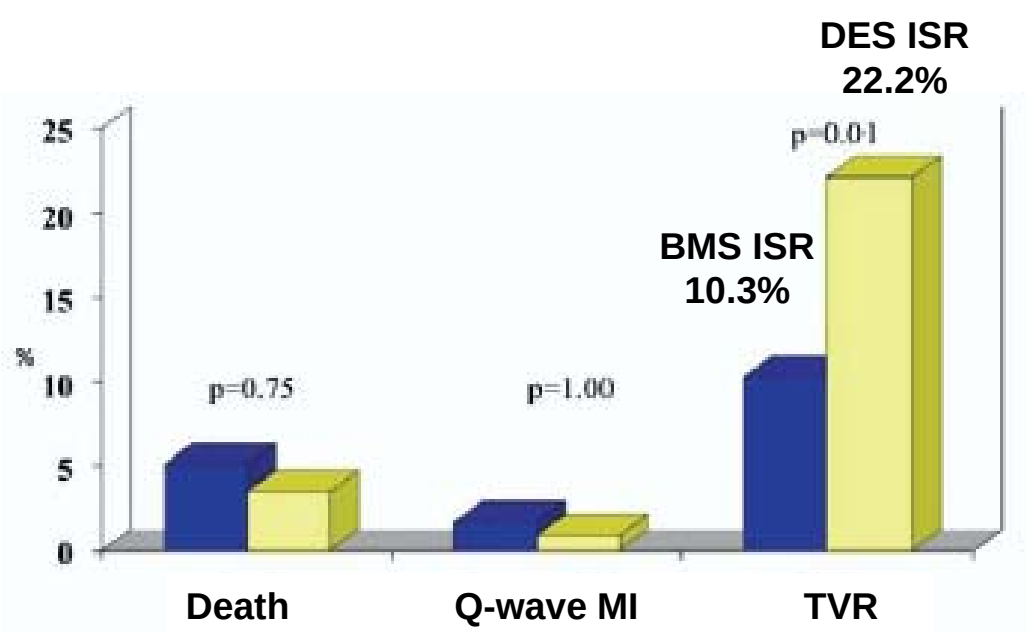


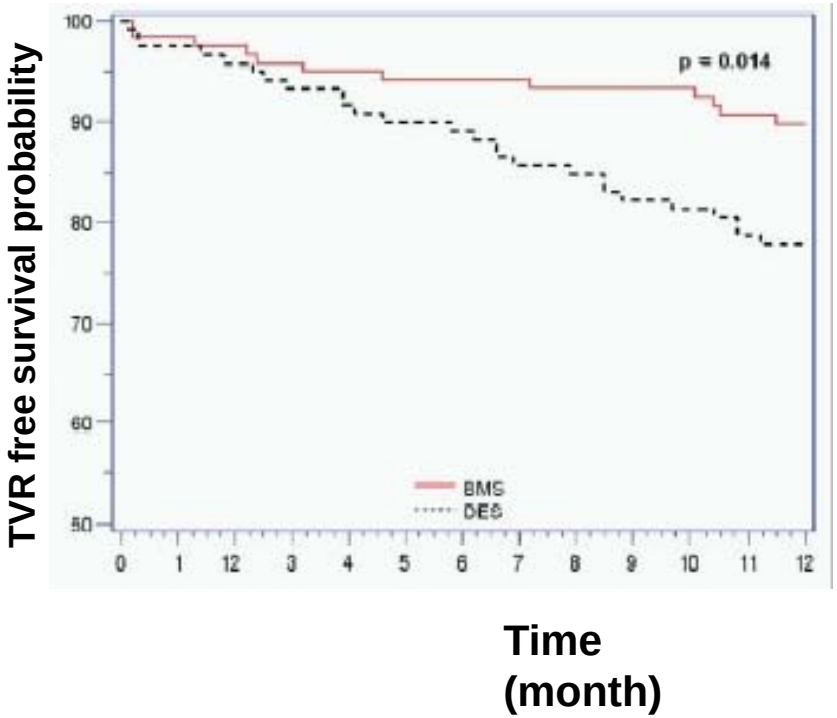
No. at Risk

Sirolimus-Eluting Stent	259	255	255	255	254	252	250	245	227	222
Vascular Brachytherapy	125	125	123	119	118	115	114	111	94	92

Holmes et al, JAMA 2006

“DES for BMS ISR” vs “DES for DES ISR”



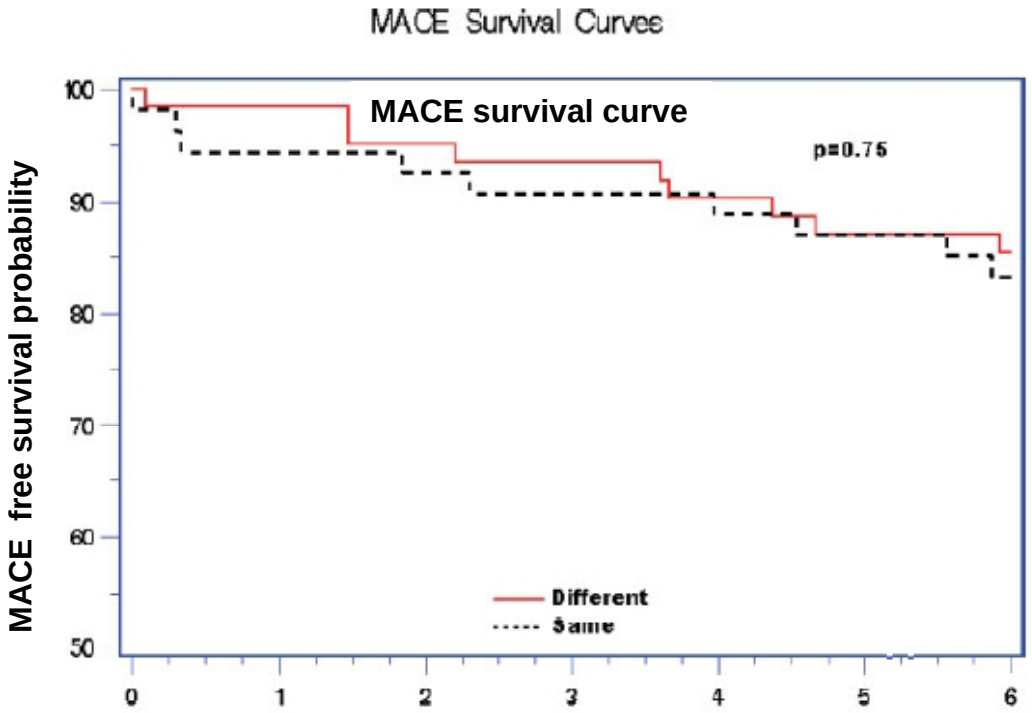


TVR more frequent in DES ISR group than BMS ISR group
→ DES ISR is more challenging scenario

Am J Cardiol 2009;103; 491-495

Treatment of DES restenosis
With the same versus different DES

Shaila Garg, MD, Kimberly Smith, BS, Rebecca Torguson, BS,
Teruo Okabe, MD, Tina L. Pinto Slottow, MD, Daniel H. Steinberg, MD,
Probal Roy, MD, Zhenyi Xue, MS, Natalie Gevorkian, MD,
Lowell F. Satler, MD, Kenneth M. Kent, MD, William O. Suddath, MD,
Augusto D. Pichard, MD, and Ron Waksman,* MD



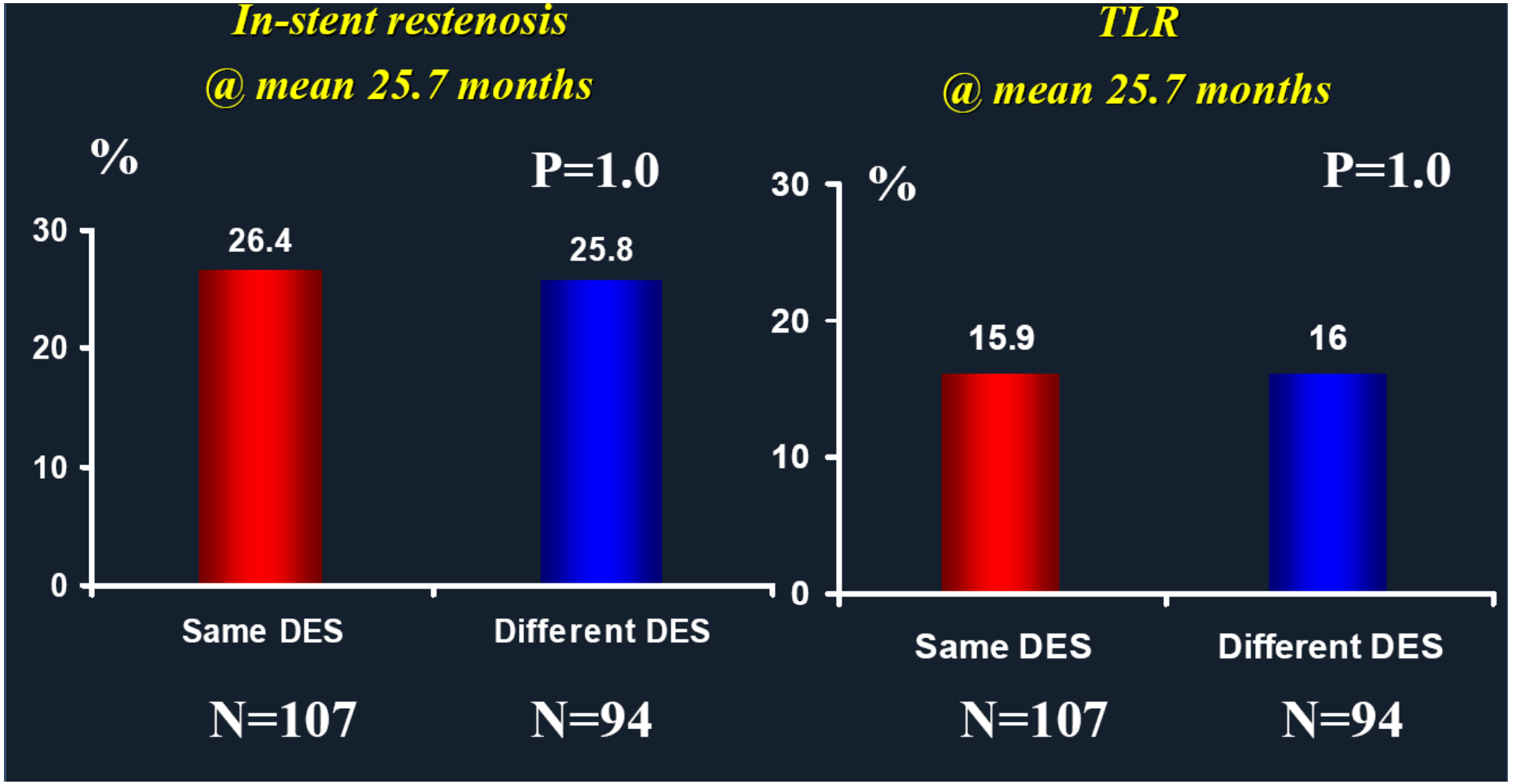
- **Switch strategy→ inconclusive**
- **1st generation DES comparison (cypher , Taxus)**

n=112

Catheter Cardiovasc Interv 2007;70:9

Does the switch therapy work?

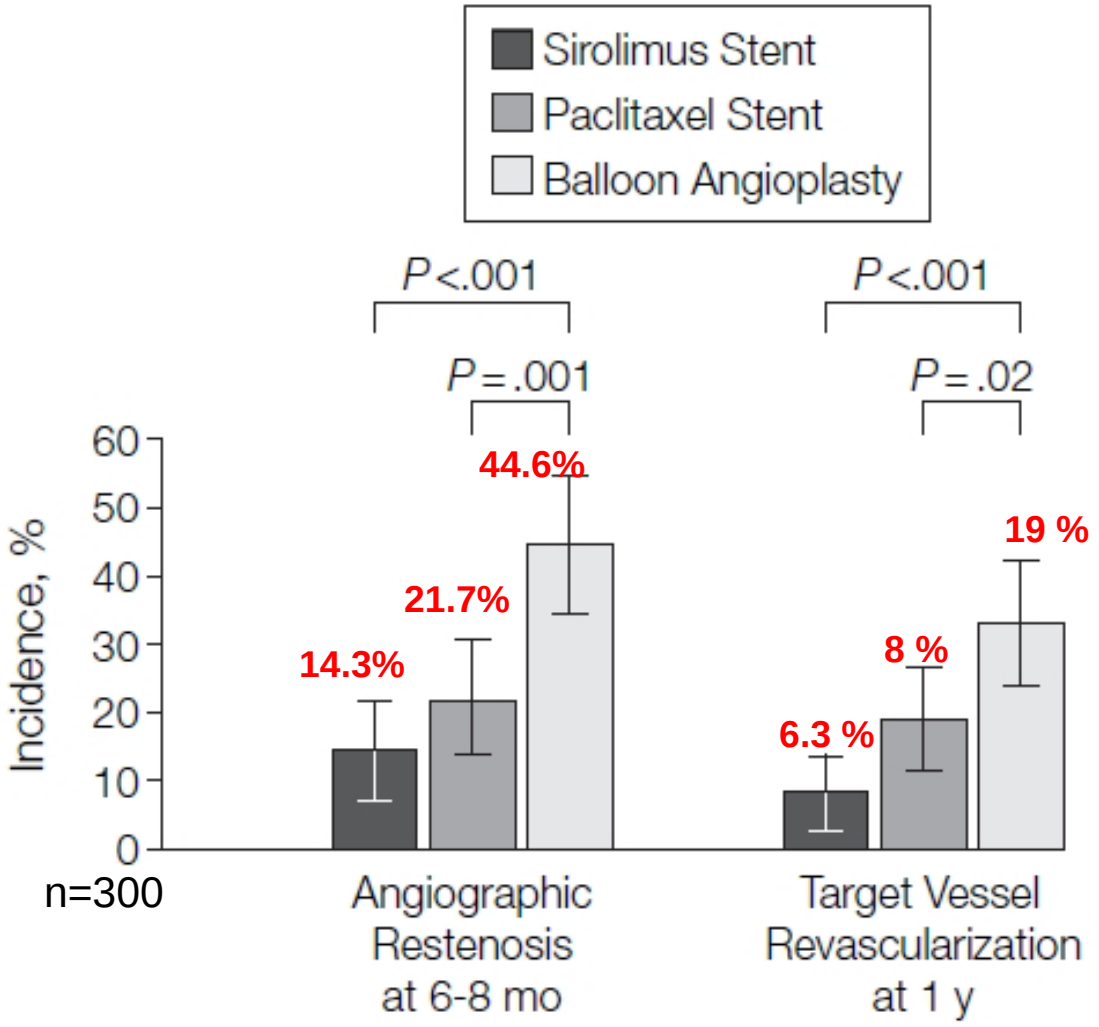
Same DES vs. other DES vs. other treatment for DES failure



Cosgrave, Colombo AHJ 2007;153:354-9

Repeat Stenting using a DES

- **ISAR – DESIRE trial**



JAMA 2005;293:165

Randomized Trial of Paclitaxel- Versus Sirolimus-Eluting Stents for Treatment of Coronary Restenosis in Sirolimus-Eluting Stents

The ISAR-DESIRE 2 (Intracoronary Stenting and Angiographic Results: Drug Eluting Stents for In-Stent Restenosis 2) Study

Objectives For patients with sirolimus-eluting stent (SES) restenosis requiring reintervention, we compared a strategy of repeat SES (Cypher, Cordis, Miami Lakes, Florida) implantation with paclitaxel-eluting stent (PES) (Taxus, Boston Scientific, Natick, Massachusetts) implantation.

Background Despite their high anti-restenotic efficacy, the widespread utilization of SES therapy has led to a significant absolute number of patients presenting with SES treatment failure. The optimal treatment strategy for such patients remains unclear.

Methods The ISAR-DESIRE 2 (Intracoronary Stenting and Angiographic Results: Drug Eluting Stents for In-Stent Restenosis 2) study was a randomized, open-label, active-controlled trial conducted among 450 patients with clinically significant in-SES restenosis at 2 centers in Munich, Germany. After pre-treatment with 600 mg clopidogrel, all patients were randomly assigned to either SES or PES implantation. The primary end point was late lumen loss, based on in-stent analysis, at 6- to 8-month follow-up angiography. Secondary end points were binary angiographic restenosis (diameter stenosis >50%) at 6- to 8-month follow-up, target lesion revascularization, the composite of death or myocardial infarction, and definite stent thrombosis at 12 months.

Results Regarding anti-restenotic efficacy, there were no differences between SES and PES in late loss (0.40 ± 0.65 mm vs. 0.38 ± 0.59 mm; $p = 0.85$), binary restenosis (19.6% vs. 20.6%; $p = 0.69$), or target lesion revascularization (16.6% vs. 14.6%; $p = 0.52$). In terms of safety outcomes, the rates of death/myocardial infarction (6.1% vs. 5.8%; $p = 0.86$) and stent thrombosis (0.4% vs. 0.4%; $p > 0.99$) were also similar.

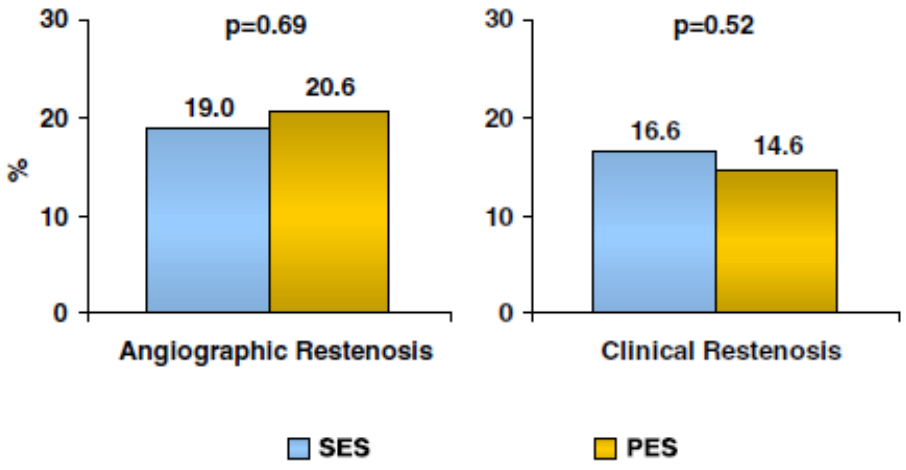
Conclusions In cases of SES restenosis, treatment with either repeat SES or switch to PES was associated with a comparable degree of efficacy and safety. Drug resistance at an individual patient level may play a contributory role to the somewhat higher than expected late loss observed with the SES in the current study. (Intracoronary Stenting and Angiographic Results: Drug-Eluting Stents for In-Stent Restenosis 2 [ISAR-DESIRE 2]; NCT00598715) (J Am Coll Cardiol 2010;55:000–000) © 2010 by the American College of Cardiology Foundation

Angiographic outcome at 1 year of ISAR-DESIRE II

Angiographic Outcomes at 6 to 8 Months

	SES (n = 205)	PES (n = 204)	p Value
Minimal luminal diameter, in-stent, mm	2.14 ± 0.78	2.16 ± 0.72	0.78
Minimal luminal diameter, in-segment, mm	1.93 ± 0.73	1.94 ± 0.67	0.98
Stenosis, in-stent, %	26.6 ± 23.6	25.4 ± 21.5	0.53
Stenosis, in-segment, %	34.0 ± 21.1	33.3 ± 18.7	0.73
Late loss, in-stent, mm	0.40 ± 0.65	0.38 ± 0.59	0.85
Late loss, in-segment, mm	0.26 ± 0.61	0.25 ± 0.58	0.86
Recurrent binary restenosis	39 (19.0)	42 (20.6)	0.69
Restenosis morphology			0.42
Type I (focal)			
Focal marginal	9 (23.0)	14 (33.2)	
Focal body	18 (46.1)	11 (26.3)	
Multifocal	4 (10.3)	6 (14.3)	
Type II (diffuse)	4 (10.3)	7 (16.7)	
Type III (proliferative)	0 (0.0)	0 (0.0)	
Type IV (occlusive)	4 (10.3)	4 (9.5)	

Data shown as mean ± SD or n (%).
Abbreviations as in Table 1.



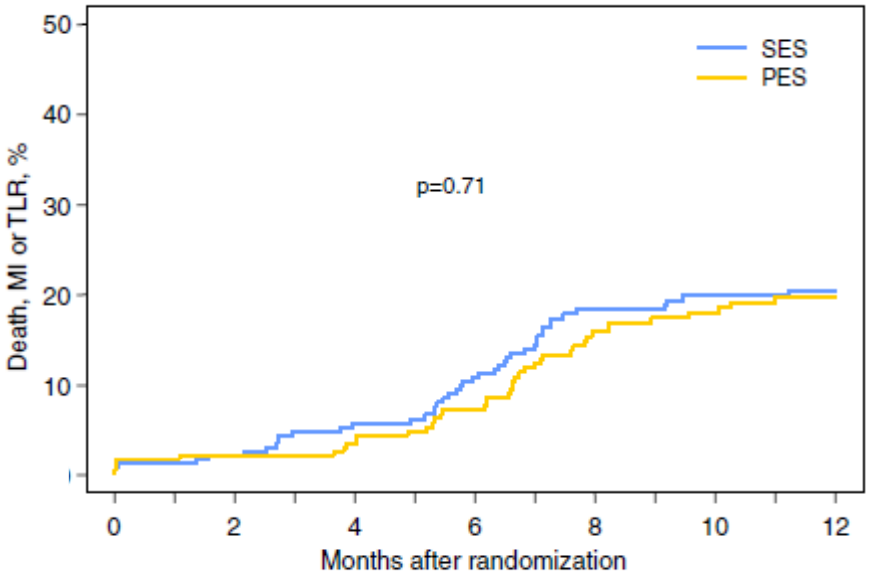
Angiographic Restenosis at 6 to 8 Months and Clinical Restenosis at 1 Year

The **blue bars** indicate sirolimus-eluting stents; the **gold bars** indicate paclitaxel-eluting stents. Clinical restenosis refers to target lesion revascularization.

Clinical result at 1 year of ISAR-DESIRE II

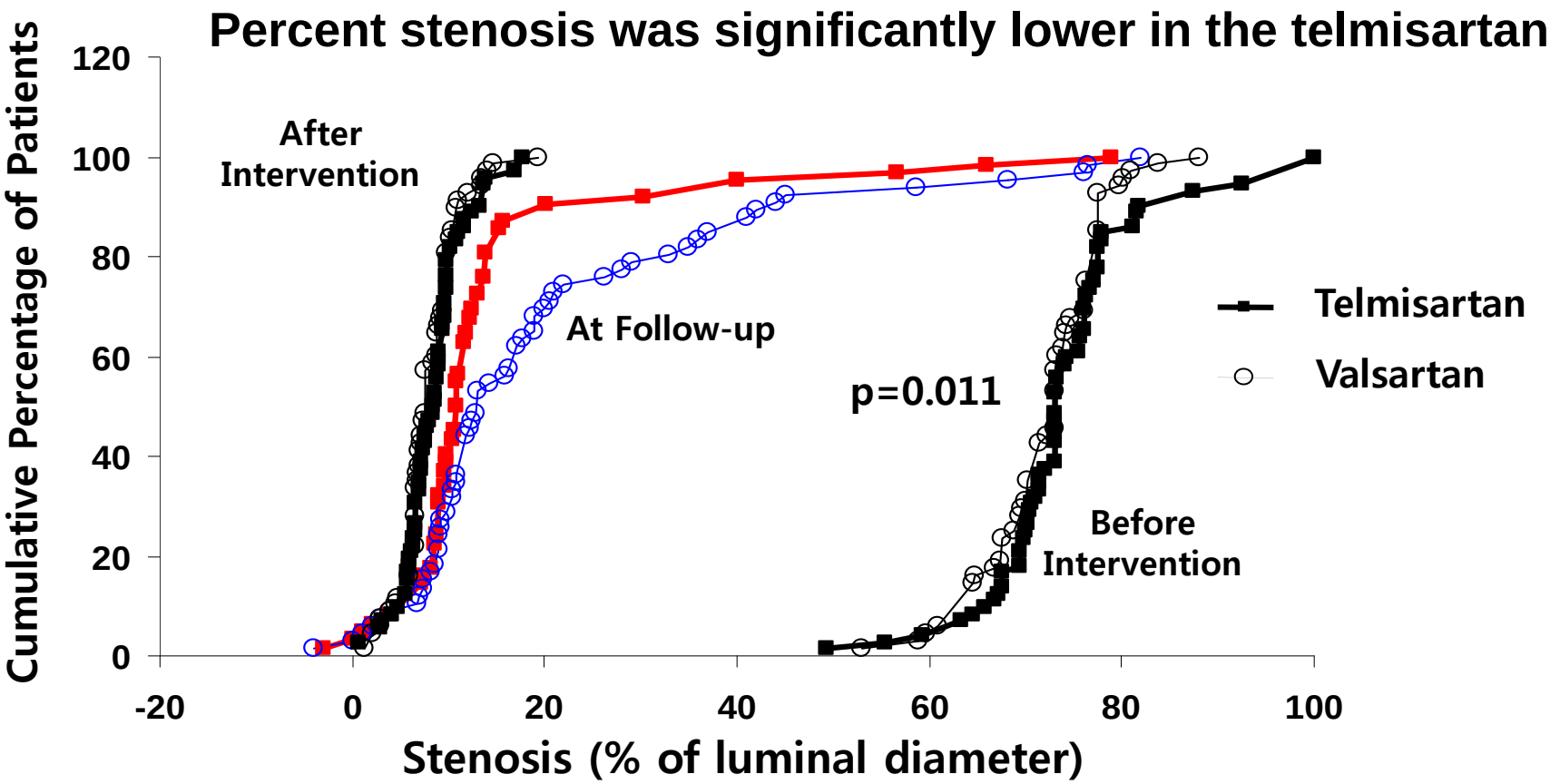
Clinical Results at 1 Year

	SES (n = 225)	PES (n = 225)	p Value
Death	7 (3.4)	9 (4.5)	0.60
Myocardial infarction	6 (2.7)	4 (1.8)	0.53
Death or myocardial infarction	13 (6.1)	12 (5.8)	0.86
Definite stent thrombosis	1 (0.4)	1 (0.4)	0.67
Death, myocardial infarction, or stent thrombosis	13 (6.1)	13 (6.3)	0.98
Death, myocardial infarction, or target lesion revascularization	44 (20.4)	41 (19.6)	0.71



Composite of Death, MI, or TLR

Comparison of cumulative distribution curves for percent stenosis



Hong SJ et al. Am J Cardiol. 2007:100(11)

Effect of 2nd generation DES for ISR ?

Prospective, single-blinded, **R**andomized comparison of the clinical and angiographic results with intravascular analysis of **E**verolimu**S**-Eluting versus Zo**T**arolimus-**E**luting ste**NT**s for **I**n-**S**tent **R**estenosis(ISR) lesions: Volumetric Analysis with Intravascular ultrasound (IVUS) :

(**RESTENT-ISR study**)

- **Prospective, randomization treatment of DES-ISR**

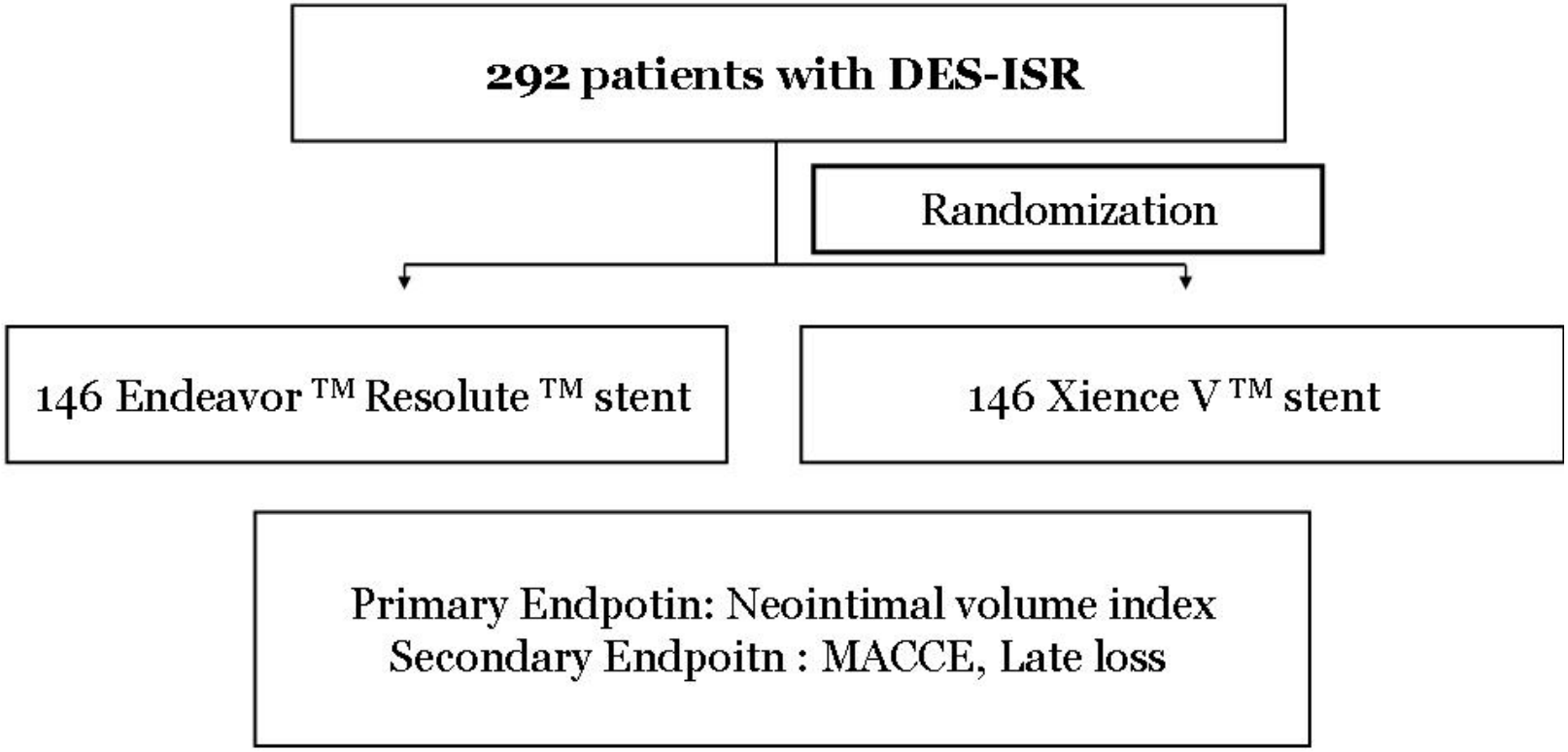
  (Xience V™ vs. Endeavor resolute™)

- **Volumetric analysis of neo-intimal hyperplasia and**

  major cardiovascular event

Restent-ISR study

Comparison of 2nd Generation DES efficacy for DES-ISR
- Primary end point : Neointimal Volume index



RESTENT-ISR

Baseline characteristics

	빈도	퍼센트
강원대학교병원	6	3.6
계명대학 동산의료원	20	12.0
고려대학 구로병원	8	4.8
고려대학 안암병원	28	16.8
관동의대 일산명지병원	3	1.8
광주보훈병원	2	1.2
노원을지대학병원	5	3.0
단국대학 천안병원	7	4.2
부천세종병원	5	3.0
성균관의대 강북삼성병원	2	1.2
성균관의대 삼성서울병원	13	7.8
순천향대학 천안병원	8	4.8
연세의대 심장혈관병원	23	13.8
연세의대 원주기독병원	8	4.8
영남대학병원	2	1.2
원광대학병원	7	4.2
전남대학병원	12	7.2
중앙대학병원	7	4.2
한림대 강동성심병원	1	.6
합계	167	100.0

- 19 centers
- **167 pts**
- Age : 62.8± 9 (31 -82)
- M:F = 111: 56 (1.98:1)

- Typical angina : 96 pts (57.5%)
- Previous MI : 38 pts(22.8%)
- HTN : 85 pts (50.9%)
- DM : 56 pts (33.5%)
- Smoking Hx : 62pts (37.2%)

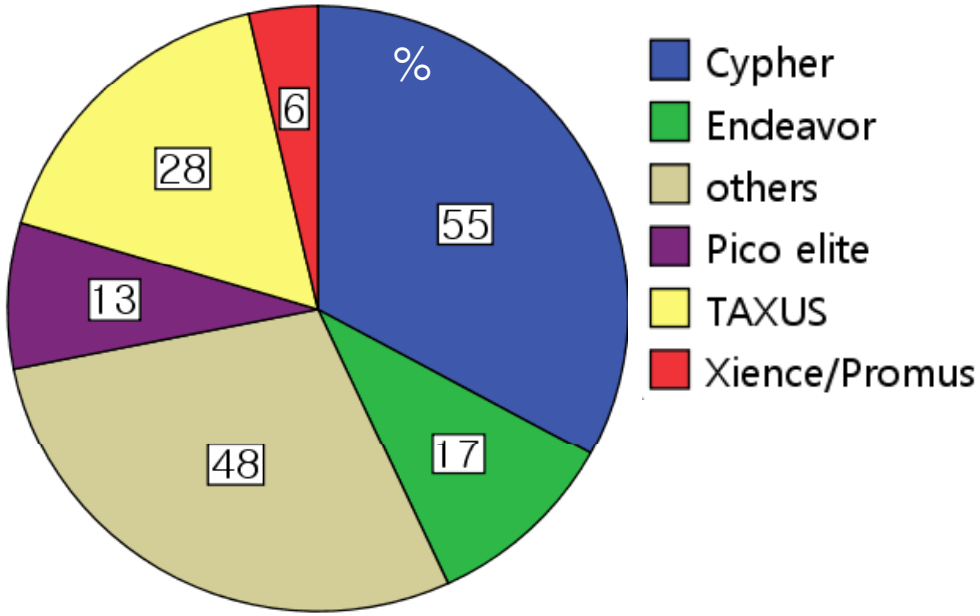
RESTENT-ISR investigator group

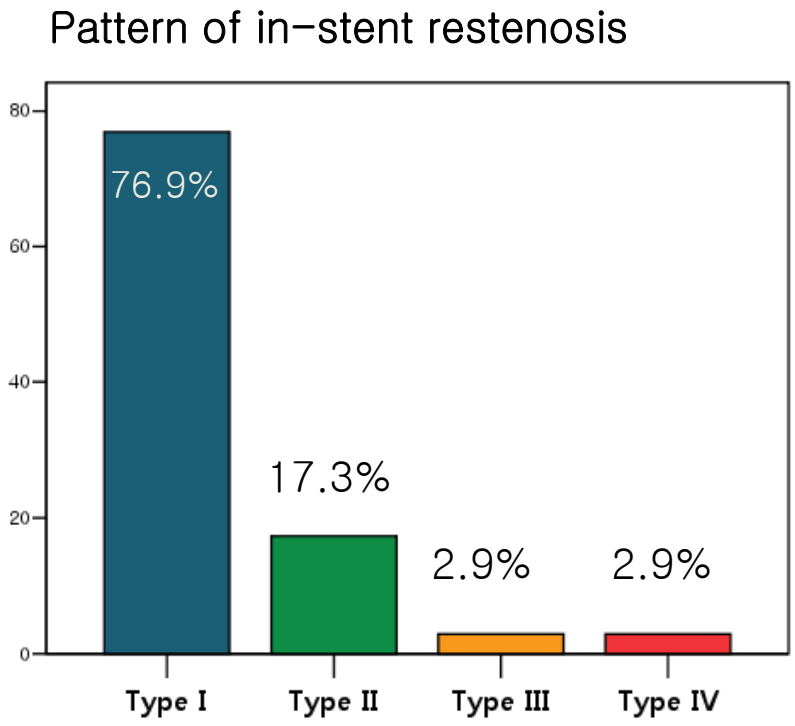
RESTENT-ISR trial - preliminary

	Xience VI (96)	Endeavor resolute(71)	P value
Age, yr	63.7±9.2	61.8±10.9	0.23
Male, n	65(67.7%)	46(64.8%)	0.69
Previous MI, n	17(17.7%)	21(29.6%)	0.19
HTN Hx, n	50(52.1%)	35(49.3%)	0.81
DM Hx, n	35 (36.5%)	21(29.6%)	0.56
Smoking Hx, n	37(38.5%)	25(35.2%)	0.78
Dyslipidemia, n	55(57.3%)	45(63.4%)	0.72
Total Cholesterol,mg/dl	140.4±36.3	150.9±35.4	0.10
LDL Cholesterol,mg/dl	79.2±26.9	83.1±27.3	0.43
Triglyceride, mg/dl	126.7±83.5	141.5±127.5	0.45
hsCRP	1.82±5.6	3.35±11.4	0.39
Ejection fraction, %	60.9±9.6	58.7±10.5	0.27
Previous stent diameter, mm	3.13±0.37	3.08±0.42	0.49
Previous stent length, mm	23.3±6.9	25.1±6.3	0.14

RESTENT-ISR : baseline characteristics

Clinical Diagnosis on presentation		Frequency(pts)	%
Silent ischemia		4	2.4
Stable angina		57	34.1
Acute coronary syndrome	Unstable angina	71	42.5
	NSTEMI	4	2.4
	STEMI	1	0.6
unknown		3	1.8





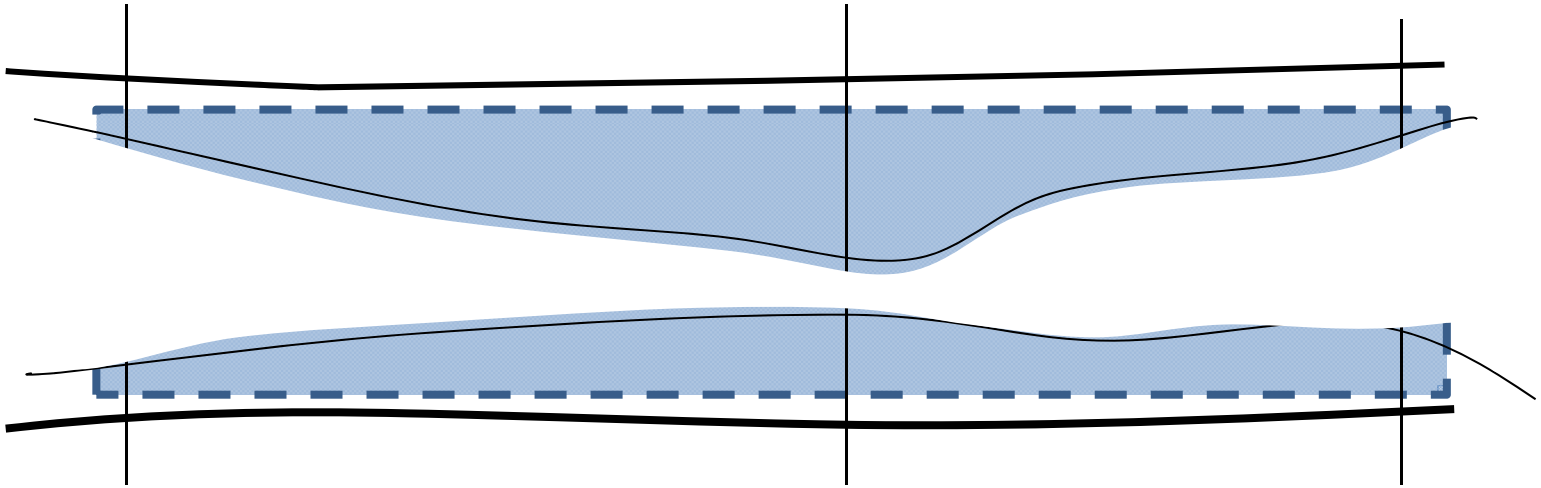
RESTENT-ISR trial – QCA & IVUS

	Xience V(96)	Endeavor resolute(71)	P value
P-Reference Diameter(pre),mm	3.05±0.61	3.11±0.59	0.66
D-Reference Diameter(pre),mm	2.96±0.89	2.86±0.52	0.47
Diameter stenosis(pre), %	72.4±15.1	77.2± 14.4	0.13
P-Reference Diameter(post),mm	3.22±0.48	3.25±0.55	0.71
D-Reference Diameter(post),mm	3.12±0.85	2.96±0.56	0.31
Diameter stenosis(post), %	11.3±10.9	11.9±14.4	0.81
Lesion Length, mm	17.3±7.73	18.1±10.5	0.67
EEM CSA_proximal, mm^2	17.5±4.85	16.6±5.02	0.54
EEM CSA minimal, mm^2	15.5±5.09	13.3±4.41	0.09
EEM CSA distal, mm^2	13.1±4.44	10.1±3.63	0.01
Stent CSA, proximal, mm^2	7.44±1.34	7.69±1.89	0.67
Stent CSA, distal, mm^2	7.23±2.56	5.93±2.05	0.08
Stent CSA, minimal, mm^2	7.03±1.92	6.32±1.78	0.19

Proximal Reference vessel

Lesion : minimal lumen

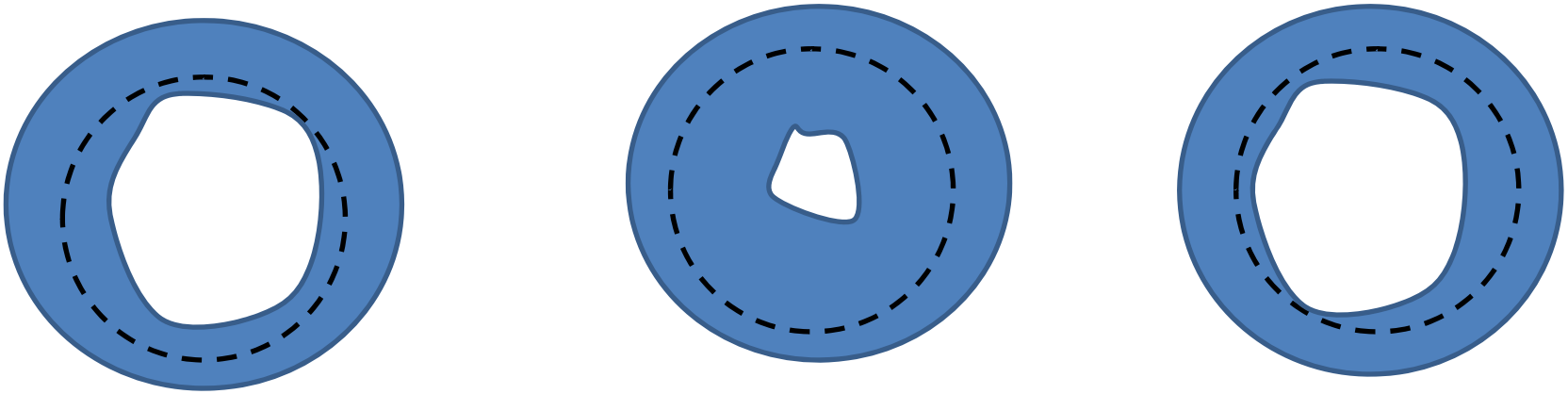
Distal Reference vessel



Stent diameter : 3.43±0.56
Lumen diameter 2.74±0.73

Stent diameter : 3.23±0.48
Lumen diameter 0.76±0.45

Stent diameter : 3.16±0.55
Lumen diameter 2.54±0.70

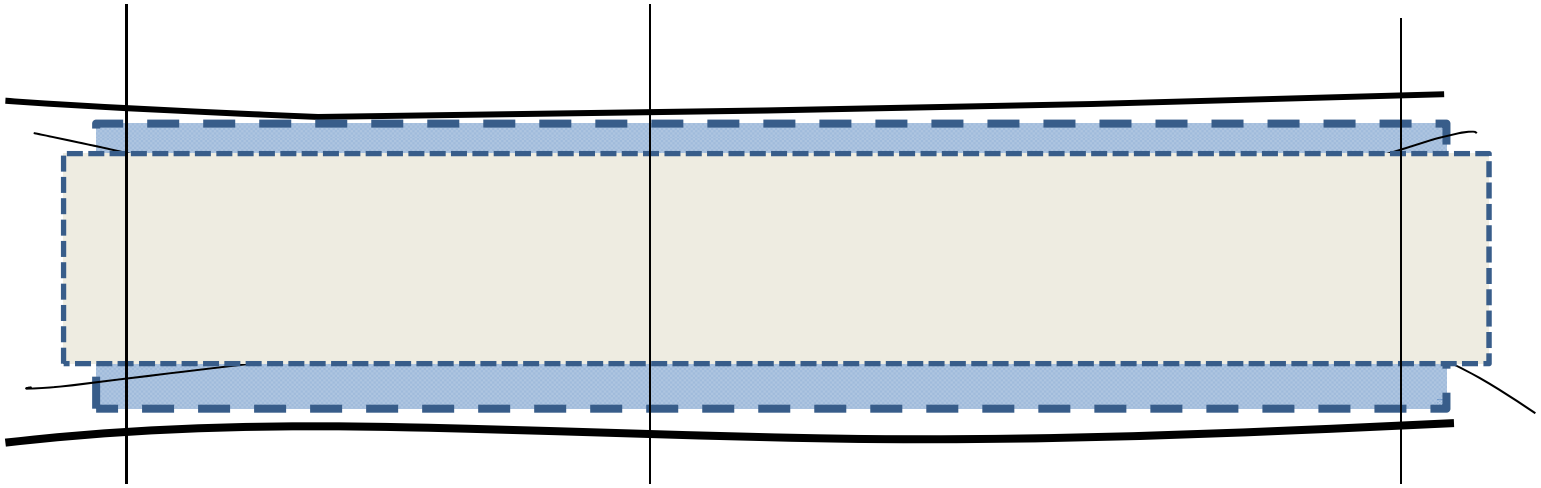


Stent area : 8.34±2.7
Lumen area : 5.4±2.9

Stent area : 7.44±2.33
Lumen area: 2.26±0.86

Stent : 7.12±2.52
Lumen area 4.66±2.66

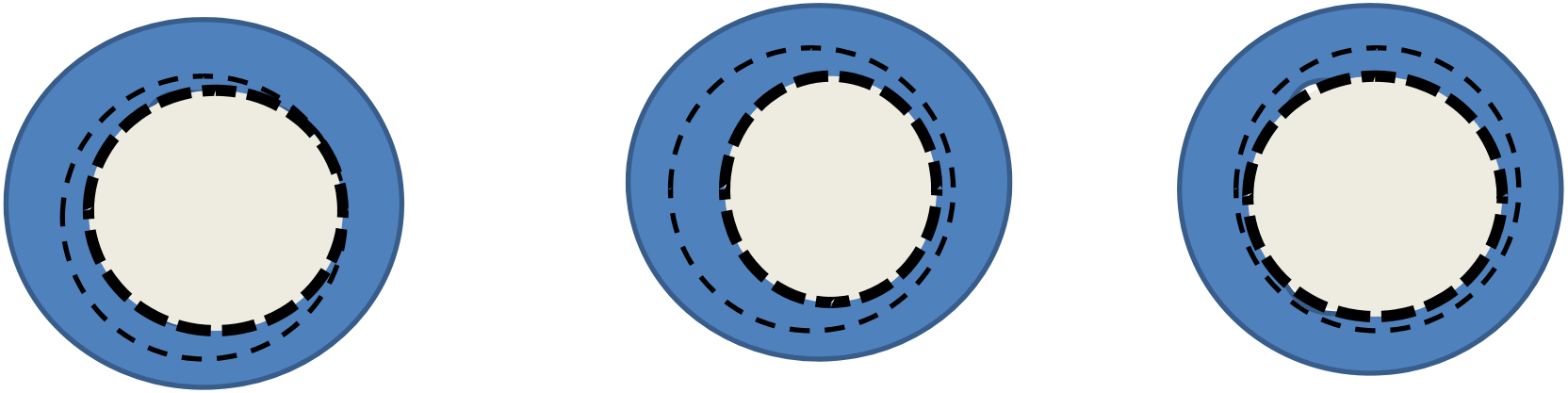
Proximal Reference vessel　　Lesion : minimal lumen　　Distal Reference vessel



Stent diameter : 3.58±0.54
Lumen diameter 3.43±0.55

Stent diameter : 3.23±0.51
Lumen diameter 2.58±1.37

Stent diameter : 3.21±0.54
Lumen diameter 3.03±0.58



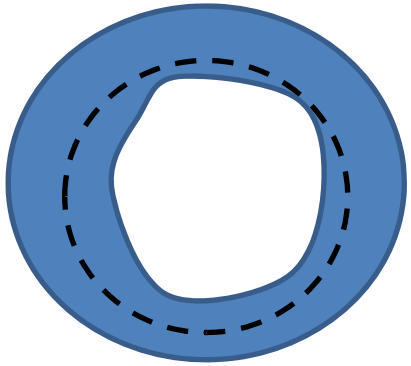
Stent area : 8.95±2.6
Lumen area : 8.35±2.84

Stent area : 7.44±2.34
Lumen area: 5.93±3.65

Stent area : 7.37±2.52
Lumen area 6.51±2.51

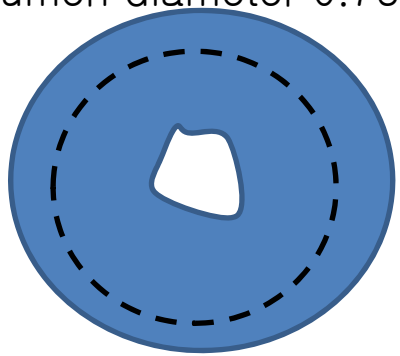
PRE-INTERVENTION

Stent diameter : 3.43±0.56
Lumen diameter 2.74±0.73



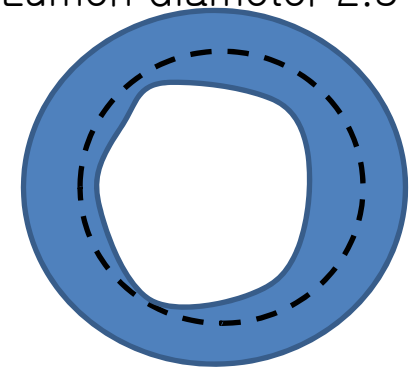
Stent area : 8.34±2.7
Lumen area : 5.4±2.9

Stent diameter : 3.23±0.48
Lumen diameter 0.76±0.45



Stent area : 7.44±2.33
Lumen area: 2.26±0.86

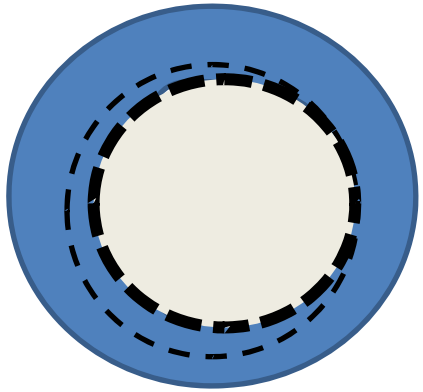
Stent diameter : 3.16±0.55
Lumen diameter 2.54±0.70



Stent : 7.12±2.52
Lumen area 4.7±2.66

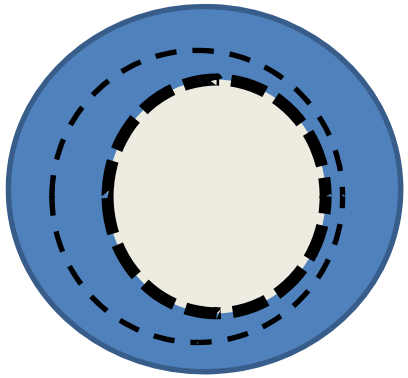
POST-INTERVENTION

Stent diameter : 3.58±0.54
Lumen diameter 3.43±0.55



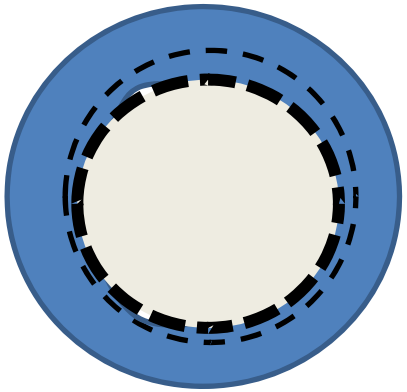
Stent area : 8.95±2.6
Lumen area : 8.35±2.84

Stent diameter : 3.23±0.51
Lumen diameter 2.58±1.37



Stent area : 7.44±2.34
Lumen area: 5.93±3.65

Stent diameter : 3.21±0.54
Lumen diameter 3.03±0.58



Stent area : 7.37±2.52
Lumen area 6.51±2.51

3rd In-Stent Restenosis(ISR) Symposium

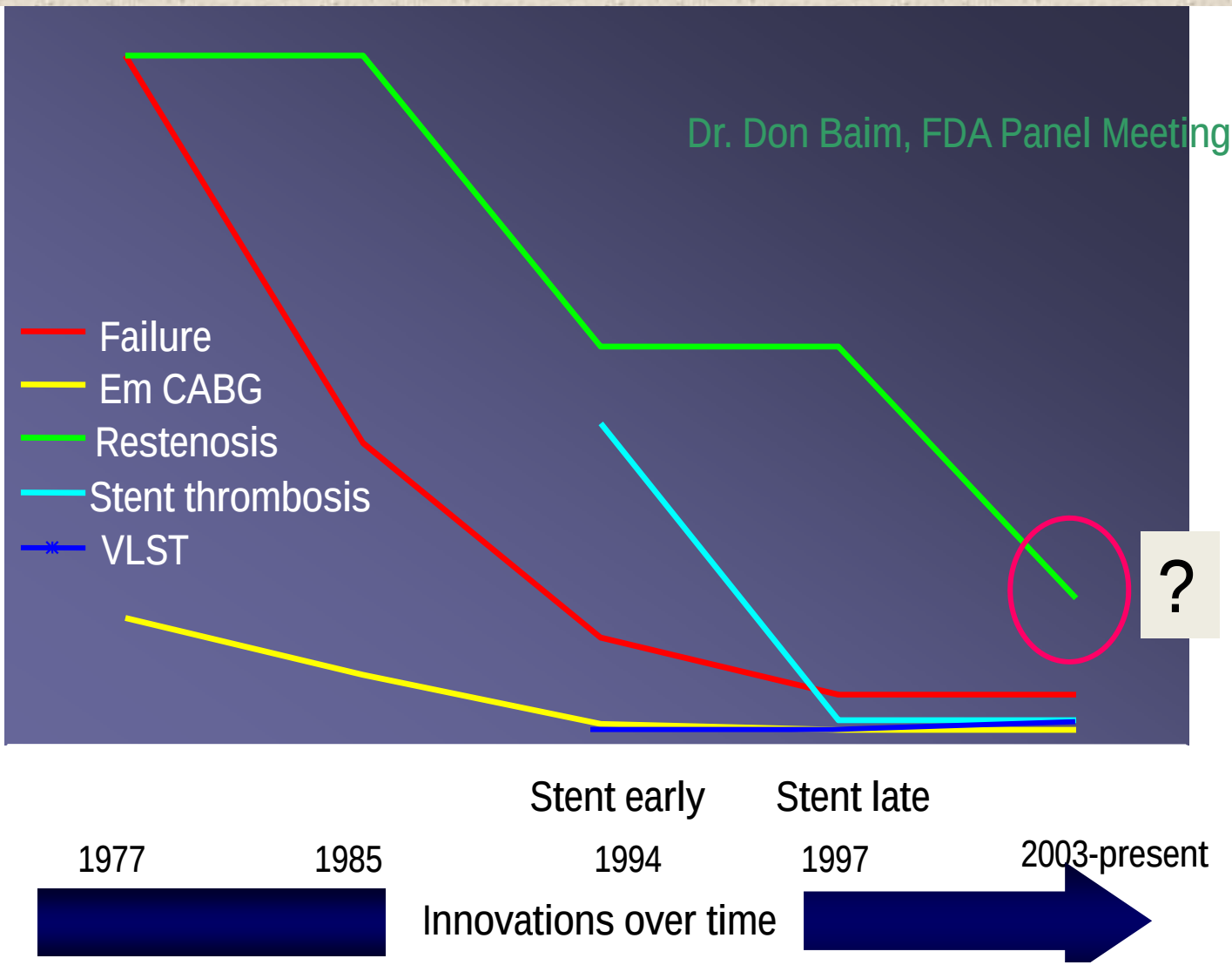
2010. 6. 25

Silla Hotel, Seoul

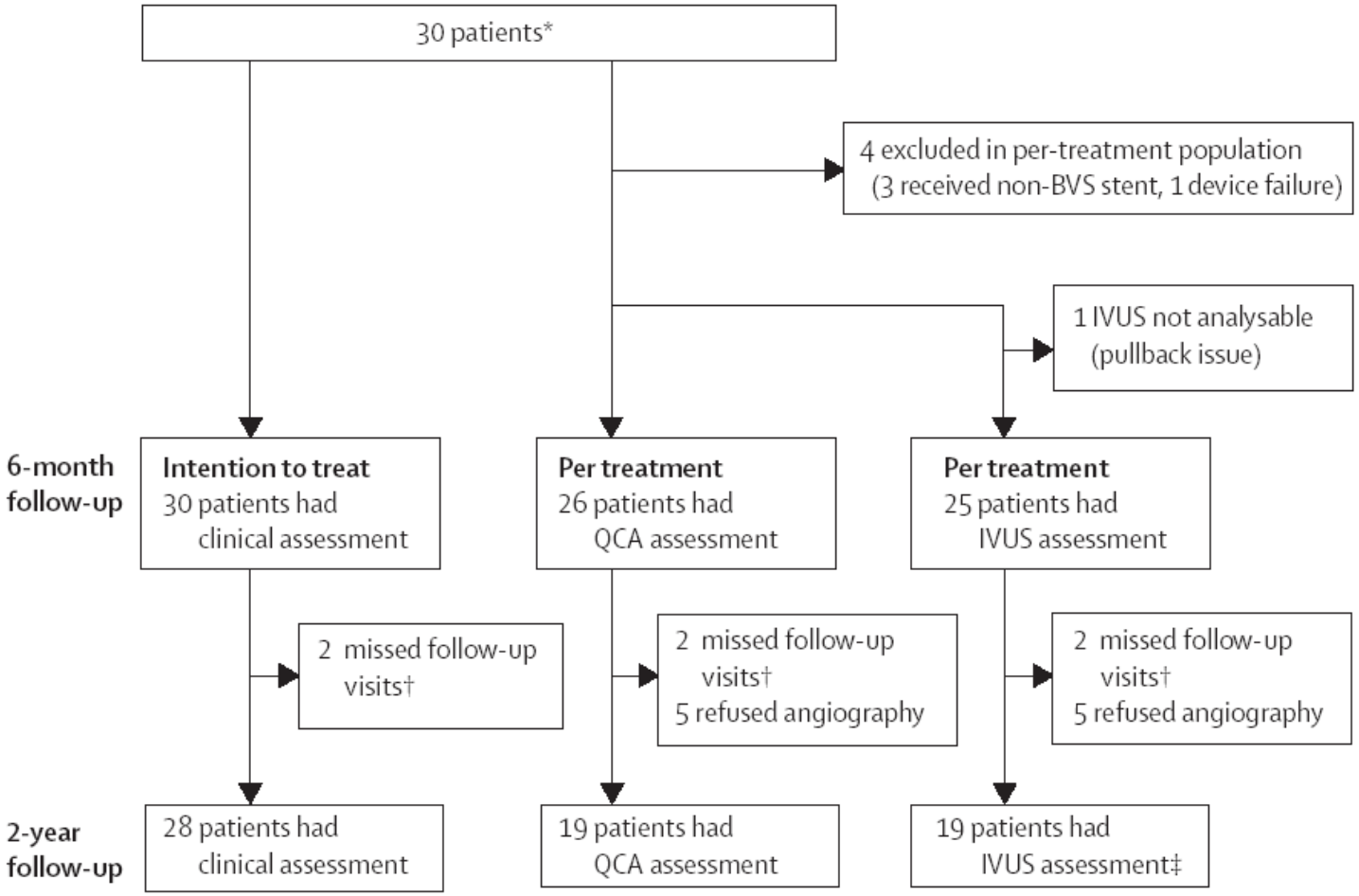
Evolution of Angioplasty

The Dominant Coronary Revascularization Therapy

Over the last 30 years, percutaneous coronary intervention (PCI) has undergone progressive improvements in success, safety, and durability, as serial new technologies have been launched.



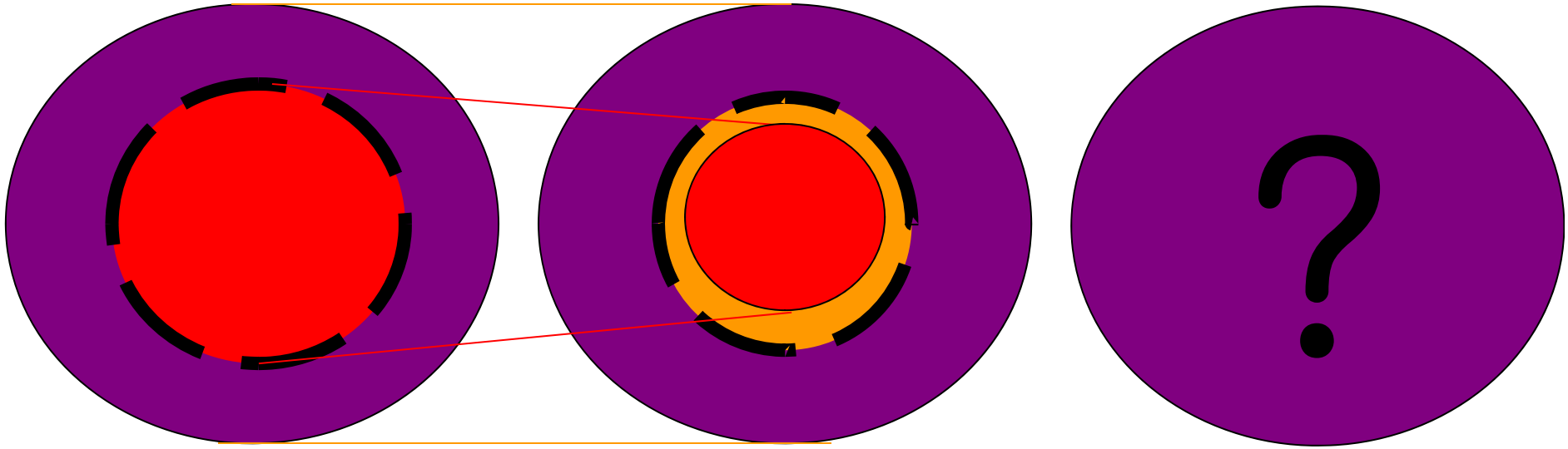
ABSORB trial



PW Serruys et al. 2009 Lancet

ABSORB
- Serial changes in IVUS

Post-stenting | 6 months | 2 years

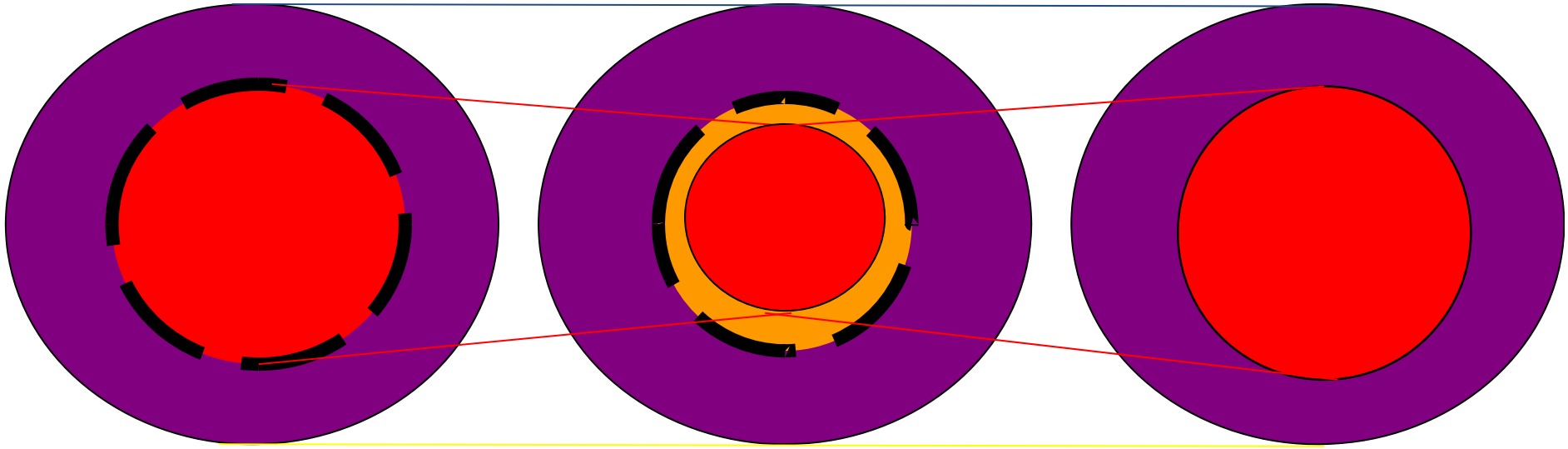


Overall lumen area reduction 16.8%	
=	
Stent shrinkage	11.8%
neointimal hyperplasia	5.5%

PW Serruys et al. 2009 Lancet

ABSORB
- Serial changes in IVUS

Post-stenting | 6 months | 2 years



Overall lumen area reduction 16.8%
=
Stent shrinkage 11.8%
neointimal hyperplasia 5.5%

Stent absorbed
Vessel size →
Plaque area ↓
Lumen area ↑

PW Serruys et al. 2009 Lancet